TOPICS OF THE MONTH

Chemical engineering and nuclear hazards

ONE of the most useful of chemical engineering's contributions to the nuclear energy field has been the development of the *Butex* process for the industrial separation of plutonium from nuclear reactor fuels, now used at the Windscale plutonium factory. The chemical engineering work that has been done in Canada in developing this process, following the chemical research at Chalk River, and at Harwell in the U.K., has now been described in a paper by Mr. C. M. Nicholls, of Harwell. The development work begun by the chemical team was continued until proved by pilot-plant operation. The process represented a considerable advance over the earlier American precipitation and Canadian *Trigly* processes.

In the operation of a radioactive pilot plant, many novel operating problems arose owing to the presence of high levels of radiation and the toxicity of the materials handled. On one occasion an accident occurred in which a few hundred millilitres of column feed solution was spilled on the operating side of the 20-in. shield wall on the third floor of the building and contaminated the third, second, first and ground floor operating areas. One to two milligrammes of plutonium and a half to one curie of fission product activity were involved. Extreme precautions had to be taken during decontamination operations to control the radiation dosage received and to avoid plutonium inhalation by the operators. The whole operation of decontaminating the plant and the building, with replacement where necessary of floors, stairs, radiators and the like, involved some 800 man-hours of work; a good indication of the nuisance potential of radioactive materials.

A hazard that occurs in chemical plants handling fissile materials in quantity is the initiation of a chain reaction with the evolution of considerable quantities of heat and dangerous radiations. This and other possibilities leads to the introduction of a novel factor in the design and operation of chemical plants, called nuclear criticality. Methods of design which take this factor into consideration have also been described by Mr. C. M. Nicholls, along with Dr. A. H. C. P. Gillieson. They recall that in the first atomic plants that were built the quantities of fissile material were comparatively small, and it was usually possible to produce safe and reasonably economic plants with only simple criticality concepts. This simple approach is no longer adequate and the policy must be to eliminate as far as possible the criticality hazard in the design of the plant rather than by control of operating conditions.

Both the papers mentioned above were presented at a symposium of the British Nuclear Energy Conference, sponsored by the Institution of Chemical Engineers and held in London on January 21, at which various contributions of chemical engineering to the nuclear energy field were discussed. A paper which was concerned more with hazards to the public than to plant and personnel was that of Mr. K. Saddington, who discussed fission product disposal and showed how the problem in Britain differs from that in America. It would seem that the U.K.A.E.A. have an eye on possible future problems and the effect they might have on the development of the industry.

Mr. H. G. Davey, O.B.E., gave a paper on the commissioning and operation of Calder 'A' power station which showed that most of the teething troubles arose on the more conventional items of equipment. At the same meeting, Mr. I. Wells and Dr. E. Lofthouse discussed the processing of fuel in homogeneous aqueous reactors, Dr. J. T. Wood and Mr. J. A. Williams dealt with the computation of the performance of a multi-component solvent extraction system, and Monsieur R. Galley (Commissariat à l'Energie Atomique, Paris) gave an illustrated description of the Marcoule plutonium plant.

Electricity in chemical works

IN seeking ways of minimising capital expenditure on chemical plants, the electrical apparatus deserves as much consideration as any. Thus, in many cases where relatively high load densities exist, the load is made up of high horse-power motors, operating at 400 volts. In order to assure immunity from interruption of supply, two or more transformers of possibly large kva. rating may be connected in parallel with a consequent increase in short-circuit capacity. This will considerably increase the cost of switchgear. Modern transformers are reliable and there is little reason why extra transformer capacity over and above that required for supplying the load should be connected in circuit. In the design of large installations it is possible that the limits of circuit breaker design are exceeded and it is necessary to reduce to within practical limits the fault power available. This can often be achieved by the wider use of 3.3 kv. for motors of the higher horse-power ratings, thus reducing the load on the 400-v. networks.

Much capital has been spent in the past on the provision of equipment for electrostatic precipitation. Some research is necessary on the development of pulsing units running at a higher potential instead of the conventional units operating at steadily maintained potential. If this is successful, saving on equipment and housing could be effected.

The cost of lighting maintenance becomes excessive on a badly designed installation and some of the standard types of lighting fittings have a comparatively short life when used in corrosive areas. Some useful designs have been developed which overcome this trouble.

The foregoing examples of possible savings on electrical equipment were given by Mr. T. S. G. Seaward, A.M.I.E.E., in a recent *Financial Times* survey, in which he points out that not only does the chemical industry use more electricity than any other but that it also expects a high degree of reliability in electrical equipment. Corrosion creates special problems and where electrical equipment has to be used in corrosive atmospheres it is necessary to design equipment with suitable materials and enclosures to withstand these conditions as much as possible. Cables, too, are subject to corrosion and even specially protected cables can have their covering damaged during installation, so leaving the wire armouring exposed to corrosion. However, Mr. Seaward reports that armoured cable with a generous serving of PVC has given no trouble even when it has received severe punishment during installation

For automatic control equipment, there is a need for attention to be paid to choice of materials and types of enclosures for use in corrosive and dusty atmospheres. The use of electrically controlled valves, too, is a development which is long overdue. These units, properly designed for flameproof and other areas, would provide more flexibility in control and increase operating speed.

Chemical containers of the future

WHEN containers for chemicals are surveyed, the glass carboy emerges as one which has been in service for a remarkably long time and which has seen little change over the past 100 years other than reducing the weight, improving the shape, shortening the neck and providing a thread formation to take a screw-cap closure. What sort of container will take its place? Mr. E. Brockley, of I.C.I.'s general chemicals division, believes that polythene, in the form of large-capacity containers, will eventually replace the glass carboy and will, as a steel-clad drum of up to 50 gal. capacity, offer the means of safely packaging many highly corrosive liquid and solid products of the chemical industry that are transported in conventional containers at present.

Speaking at a meeting of the Institute of Packaging in Manchester on February 5, Mr. Brockley observed that, next to bulk packaging, the metal drum carried the highest tonnage of chemical products—liquid and solid. The multiwall paper sack for solids had in recent years, however, made great inroads into what would otherwise have been the sphere for metal drums, but such had been the expansion of chemical manufacture that little had been felt of this move in the drum industry so far except, paradoxically, in the case of heavy drums.

Stainless steels, pure aluminium and its alloys have been brought into use for containers in recent years, stainless steel being particularly useful for corrosive liquids which react dangerously with conventional steel, such as those which decompose rapidly and perhaps in so doing develop a pressure. But use of stainless steel involves a heavy cost, and such drums are confined to extremely difficult-to-package products. Pure aluminium drums—still expensive at about £25 each—are in use for certain chemicals, while other drums are of steel lined with plastics, etc.

Refinery gas to town's gas

SOME interesting things have been tried out in Britain's gas industry lately in the quest for alternatives to the use of high-cost carbonising coals, and the latest development is the North Thames Gas Board's idea of piping refinery gas from Shellhaven on the Essex coast to Romford some 15½ miles away for treatment and distribution. Between these two points runs a 24-in. steel main which was one of the biggest mainlaying operations ever undertaken in Britain, costing £500,000.

One point of importance is that the steel main required gas free from sulphuretted hydrogen and water in order to forestall the corrosion hazard. This, in turn required the purification of the refinery gas at the refinery site. When it reaches Romford the purified gas with a calorific value of 1,500 B.Th.U. has to be transformed to one of 500 B.Th.U. The Romford plant will be operated on the *Onia-Gegi* principle, the rights for this process being held in Britain by Humphreys & Glasgow Ltd., who have been given the contract for erecting the plant.

The total cost to the North Thames Gas Board of this new venture is £1,789,000. This will produce as much gas as a conventional coal carbonising unit which would cost us at to-day's prices £4,380,000. The capital cost will be 1d. per therm as against 2. 9d. per therm by traditional plant. The addition of tail gases from Coryton and methane from Canvey open up an even greater prospect for the future.

Dead Sea potash looks lively

WHILE Jordan, as reported on another page, is preparing to make an onslaught on the Dead Sea potash deposits at the Jordan end, Israel, making the most of the bit of the Dead Sea that comes within its borders, has been increasing its potash production and in 1957 the output of Israel's Dead Sea works totalled 78,000 tons—some 70% more than the 1956 figure. The entire quantity was sold, the greater part being exported, bringing in $2¼ million.

This is reported in a recent review by Barclay's Bank, which also states that production of phosphates in Israel has now reached 21,000 tons/month. It is hoped that by next year the annual production will be 250,000 tons, of which 150,000 tons will be available for export. As there is a growing world demand for phosphates, there are extensive export possibilities for Israel's industry provided that internal transport difficulties can be overcome and the price is competitive.

A newly discovered phosphate deposit in the Southern Negev is to be surveyed by an Italian chemical organisation and the Ministry of Development.

Thermonuclear energy

A NOTICEABLE thing when the Harwell work on controlling the fusion reaction was announced was that the popular newspapers, although giving the achievement the sensational headlines it deserved, and discussing its practical significance with varying degrees of accuracy, made their reports, on the whole, unusually sensible and informative. This was due no doubt to the pains which the U.K.A.E.A. took to ensure that thermonuclear fusion did not develop into thermonuclear confusion and that all available facts were made public.

At any rate, through the daily and weekly press, scientists and all who are interested in scientific matters have been regaled with photographs and diagrams of *Zeta* from every possible angle and the now familiar torus and transformer have been the object of close, if unrewarding, scrutiny by people far removed from the atomic energy industry. But their guess is as good as anybody's. While justly proud of the remarkable achievement of Dr. Thonemann *et al.* in attaining temperatures of 5 million °C., the U.K.A.E.A. is being cautious about the future of *Zeta* and its possible successors. While there is good reason to think that the neutrons that have been observed come from thermonuclear reactions, they could equally well come from other reactions, such as the collison of deuterons with the walls of the vessel, or from bombardment of stationary ions by deuterons accelerated by internal electric fields produced in some forms of unstable discharge.

Then, too, the energy produced in the fusion reaction at present is only about a million-millionth of the energy input and, in order to 'break even,' the experimenters will have to produce temperatures of about 300 million degrees in deuterium gas and about 40 million degrees in a mixture of deuterium and tritium. New methods will have to be devised to heat the gas to higher temperatures and new techniques will be required to measure the temperatures. Even if all goes well there will still be the further engineering problem of designing and constructing a prototype of the practical and thermonuclear power station. So, as Sir John Cockcroft pointed out in announcing the *Zeta* development, it is difficult to see far enough ahead to say whether and when the final goal can be achieved.

A major problem in *Zeta* has been to keep the column of hot gas away from the walls of the container, since higher temperatures are achieved with a constricted column and contact of the hot gas with the wall would obviously vaporise the material, as well as causing contamination of the gas. The electric discharge which heats the gas produces an intense magnetic field which causes the discharge to become constricted, but also causes it to 'wriggle about.' The 'wriggling' has been suppressed by applying an additional steady magnetic field parallel to the axis of the tube.

One striking feature of the British experiments is the size of the tubes. The Americans have used tubes of not more than 5-in. bore and 75-in. track length, while the British, in *Zeta*, have attained a bore of 39 in. and a length of 360 in. The larger tubes are held to minimise chance of contamination of the discharge from the tube wall materials. The British, too, are the first to use metallic tubes, leading to smaller volatilisation contamination, and more favourable magnetic conditions. The Americans plan a large version of the *Stellarator*, but this will not be ready for some years yet.

The Americans have expended sums during 1954, 1955 and 1957 which are respectively two, three and 30 times that spent in 1953 on this project. They now employ over 500 people on their Sherwood project. On the other hand, *Zeta* has cost a mere £300,000, and in Britain there are only about 50 at Harwell, and a few at the A.E.I. working on this problem. Perhaps the American policy of spreading resources over a wide field of attack is not necessarily the best one.

Automatic control of leaf filters

A SIMPLE but effective method of measuring the thickness of the filter cake inside a leaf filter has made an appearance in America and is claimed to do away with the need for an operator. It is also stated that with automatic operation it is possible to use a filter's entire capacity and a smaller unit can be used.

The indicator has two pressure-sensing probes which are hooked up to a differential pressure switch. One probe reads the pressure of the slurry in the filter. The second, an adjustable one, is set up near the end filter leaf. If a 1-in. cake is desired, the second probe is placed just a little less than 1 in. from the leaf. While filter cake builds up on the leaves, the pressure at each probe is the same. But when the cake reaches the 1-in. thickness, the second probe is embedded slightly in the filter cake, records a lower pressure than the first probe, and the differential pressure switch goes to work. The switch either sets off an alarm for manual shutdown or automatically starts the cleaning cycle. Details were given in *Chemical and Engineering News* of November 25, 1957.

High-temperature microscope

WHILE the basic idea of direct observation of high-temperature processes is not new, a technique which has been developed recently is claimed to afford a degree of flexibility and accuracy not previously attained, and the method appears to be sufficiently versatile to find useful application over a wide field of study.

In the technique described by Mr. J. H. Welch, of the Building Research Station, D.S.I.R., to the Road and Building Materials Group of the Society of Chemical Industry on February 20, the material to be examined is held under a microscope at the tip of a thermocouple which is heated electrically to fuse the sample, and which also serves to indicate the temperature at which any observed change occurs in the melt. The different compounds present in the semi-molten

material can be identified and their melting range can thus be determined by direct observation. Mr. Welch showed some examples of cinemicrography illustrating the advantages of a dynamic study of melt behaviour for isolating and identifying compounds, and for making general observations on viscosity and rates of crystal growth.

Recent improvements on the original design have permitted observations to be made in special atmospheres. By this means it has been found possible to observe the behaviour of materials that are opaque in normal atmospheres, as for example some blast furnace and steelmaking slags and coal ash slags which may contain considerable proportions of iron oxide. A further modification has extended the range of observations to about 2,300°C., although the precision with which the temperature of the specimen can be estimated is somewhat lower than for the normal range of the instrument up to 1,800°C. The most recent development of the apparatus is in the form of a high temperature *x*-ray camera, suitable for powder diffraction work up to at least 1,700°C.

The value of direct observation in the manufacture of building materials becomes apparent when it is considered that many of these materials are processed at high temperatures, among them being cements and slags. Their behaviour in use depends on the chemical constitution and proportions of the compounds present, and these are dependent on the composition of the raw material and the heat treatment to which it has been subjected. Consequently much time has been given at the Building Research Station and elsewhere to studies of the constitution of the principal chemical compounds produced from the original raw materials and to the sequence of their formation for various ranges of temperature and composition.

A mile of glass piping

THE efficient disposal of noxious liquids from technical laboratories is a problem, as the volume and corrosive nature of liquids used are difficult to contain in a pipe. Q.V.F. Ltd. have developed a system of glass waste-lines and sink traps which meet both these requirements, and at Nottingham Technical College members of the technical press recently had an opportunity of seeing one of the major installations of this type of laboratory disposal system.

The entire installation is completely sealed and has no open traps. Beginning on the seventh floor of the building, it forms one continuous system to the outside drains. The main stacks consist of lines of 4-in. bore, with 3-in., 2-in. and 1½-in. bore lines at intermediate stages. The whole installation is fitted within ducts through the walls and the horizontal lines are carried in the floor/ceiling cavities.

The most remarkable thing about the installation is that, although there are 248 sink units, each with its own sink trap constructed of glass, any build-up of solids can be detected at once. The trap can then be opened by hand and the blockage cleared.

Crop Protection and Pest Control Exhibition

THE value of chemical fertilisers as an aid to raising the food so desperately needed to feed the world's increasing masses is fairly universally appreciated; another increasingly important use for chemicals in agriculture and horticulture is in the protection of crops and the control of pests. Just how big and important this latter field has become will be demonstrated at the Crop Protection and Pest Control Exhibition to be held in London from May 12 to 15 under the sponsorship of *World Crops*. This completely new, specialised exhibition will provide a medium for the display and sale of insecticides, pesticides, fumigants, rodenticides, herbicides and weed killers, insect repellants, timber preservatives and treatments, disinfectants, etc., as well as a whole range of machinery, apparatus and services for weed and pest control.

The world-wide interest that this exhibition has already aroused is evident from the fact that representatives of some 59 overseas governments have already given notice of their intended appearance, while a great number of scientific and educational bodies both at home and overseas will also be represented. Exhibitors will not only include suppliers of the various chemicals, equipment and services but also suppliers of raw materials, while such stands as that of the Department of Scientific and Industrial Research will help to ensure a complete coverage of this field.

Electronic tool for tracer investigations

PLANS to use a multi-channel scintillation spectrometer in Finnish investigations, which will result in increased efficiency in cellulose, pulp, paper and other plants, mark a new departure in processing control where Europe is concerned. It has also been reported that an installation based on similar principles will shortly be introduced in one of Europe's largest cement works.

The multi-channel spectrometer might perhaps be described as a multi-station spectrometer controlled from one central point. At each station one has a photomultiplier phosphor pre-amplifier unit, and the stations are connected by cables to the central control point, which also contains the necessary power supplies. In this way one operator can record vital information concerning the operation of a complete processing system. The units have been for four stations or six stations, but this can be varied to meet particular requirements.

The advantages of being able to follow the progress and behaviour of one or more selected raw materials or ingredients simultaneously through the pipeline of processing and mixing at any stage of manufacture, and to locate trouble at the precise point where no visual means exist, will be recognised to have applications to any industry concerned with flow and mixing techniques. According to Nuclear Enterprises (G.B.) Ltd., who are now making this type of equipment available in Britain, the system is already used experimentally in the fertiliser industry with excellent results.

Mechanised Production of Carbon for Aluminium Smelting

One of Canada's major new projects is the Baie Comeau aluminium undertaking, the first stage of which has recently started production, as noted in our February issue (page 38). To keep the reduction furnaces supplied with carbon there is a carbon factory which is outstanding for the high degree of mechanisation and automatic control it embodies. Main features are discussed in the following article.

THE new aluminium smelter of the Canadian British Aluminium Co. at Baie Comeau, on the North Shore of the lower St. Lawrence River, represents an important British investment the company being a subsidiary of the British Aluminium Co. Ltd., and formed in partnership with the Quebec North Shore Paper Co. With the first stage completed, work on the second stage of the smelter is already well advanced and will be completed by the early spring of 1959, when the company will have a production capacity of 80,000 tons p.a. of virgin aluminium. Later, work is expected to proceed on the two final stages which will bring the annual capacity to 160,000 tons.

The two furnace rooms for Stage 1 are more than 1,700 ft. long with a rectifier house at one end and a casting shop at the other. Each furnace room has 84 furnaces of the vertical stub Soderberg type, connected in series.

The aluminium-production process requires about half a ton of carbon for every ton of metal produced and so, in addition to the furnace rooms, laboratory, service building, etc., the plant at Baie Comeau includes a carbon factory which provides both the carbon paste for the anodes of the furnaces and carbon mixture for lining the furnaces. The plant is designed so that exceptionally close control can be exercised over its operation, and operating labour reduced to the minimum by the centralisation of all controls.

Carbon production

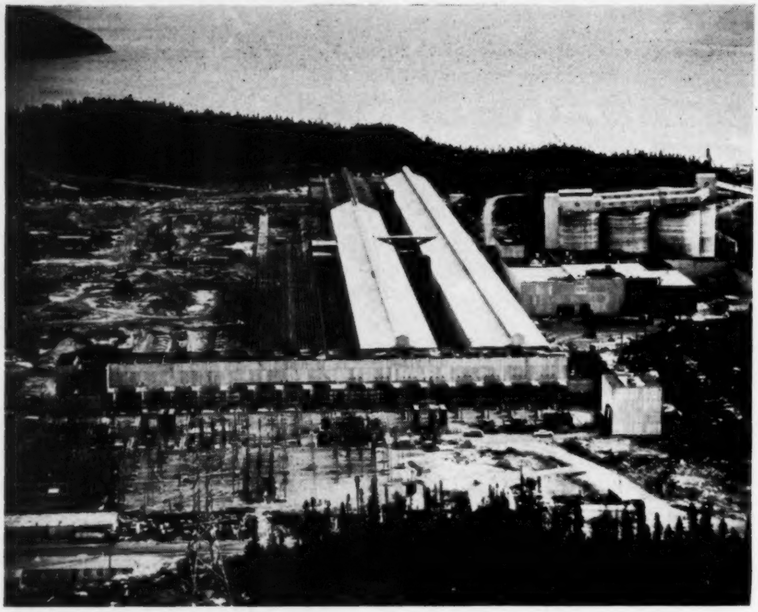
The annual production capacity of the carbon plant, based on a 36-hr. week, is 24,400 long tons, and double this amount for two-shift working, giving a 72-hr. week. In addition to anode paste production capacity, capacity for pot-lining mixture is provided at 2,500 long tons p.a.

Anode paste is prepared from calcined petroleum coke which, after suitable treatment, is mixed with pitch; the grist for the preparation of the furnace lining material is similar to the anode grist but with calcined anthracite replacing the petroleum coke and the pitch for the binder being softened with creosote. Carbon production involves the following operations:

(1) Unloading and conveying of raw material.
(2) Drying of calcined petroleum coke or calcined anthracite coke.
(3) Conveying, screening and crushing.
(4) Fine grinding.
(5) Anode paste preparation (grist pre-heating, mixing, briquetting and cooling).
(6) Preparation of lining mix.
(7) Hard pitch and creosote pumping and metering.

Treatment of the calcined coke after its withdrawal from storage in two 6,000-ton silos involves drying in a rotary, oil-fired drier and its separation into various size fractions from $\frac{1}{2}$ in. to dust by screens, the finer sizes being made as required by reducing any excess coarse materials first in roll crushers and subsequently in an air-

The 'brain' of the carbon plant supplying the Baie Comeau aluminium smelter is a central control room housing three separate control panels. The panel shown here includes an illuminated flowsheet.



A recent view of the first two of the eight smelter bays at Baie Comeau, each of which is one-third of a mile long. The third bay is also under construction. The switchyard is in the foreground with the rectifier room running horizontally across the rear end of the smelter bays. Ancillary buildings and alumina silos are on the right.

swept ball mill. Predetermined quantities of each size fraction of coke are then blended and fed to the continuous mixers with molten pitch.

Special heating medium

For the melting of hard pitch, as well as for the maintaining of temperature of the pitch in the holding tank and the pipelines, and also for the heating of both mixers, batch and continuous, *Hydrotherm* heating fluid has been introduced. This is pumpable from 50 to 600°F. For the melting of pitch the *Hydrotherm* is heated to 550 to 580°F. and circulated in the melter and held at the desired temperature of the liquid pitch.

The heating medium has the advantage of being non-explosive or flammable at up to 600°F. and is not poisonous. Any other heating media such as steam would be more expensive owing to the necessity of high-pressure, jacketed piping and large condensation needed for such an installation. Hot oil as a heating media would bring explosion or fire hazards at such a high temperature.

The *Hydrotherm* is heated by a liquid heater with two burners, providing approximately 6 million B.Th.U./hr. These two burners can be operated easily from the heater, or from the control room where all instrumentation is concentrated. Temperature control and safety control for this furnace are completely automatic.

The *Hydrotherm* system has been divided into a low-temperature and a high-temperature system; the high-temperature system being used for melting and the low-temperature for the heating of all pipelines and the mixers. The high-temperature circuit is made up of freshly heated *Hydrotherm* and the low-temperature circuit contains *Hydrotherm* returning from the jackets of the pipes or coils of the high-temperature circuit. The whole *Hydrotherm* heating system is a gravity and not a pressure system and the system has an open expansion tank.

Continuous mixers

Two Baker Perkins K.E.400 R.M. continuous *Ko-Kneaders* are provided, these machines comprising, basically, a worm blade revolving in a closed, jacketed trough. The blade has gaps at regular intervals to correspond to kneading teeth in the trough wall, and is operated by a driving gear that produces a horizontal movement so coordinated with the rotary motion that the gaps meet and pass the kneading teeth as the worm revolves. The metered feed stock is forced forward by the worm blade until it comes to a kneading tooth; as the blade passes the tooth it forces a part of the material with it and leaves part behind. This process is repeated along the entire length of the trough as the blade passes each kneading tooth and this repetition ensures the essential mixing and blending of the carbon and pitch components to yield a thoroughly homogeneous paste.

At Baie Comeau the finished paste is extruded through a special die in the form of ribbons or bars. These are delivered on to cooling conveyors and cut crosswise by a cutting device to give blocks of carbon paste which are then cooled and stored as briquettes, ready for feeding to the anodes of the reduction furnaces.

Batch mixers

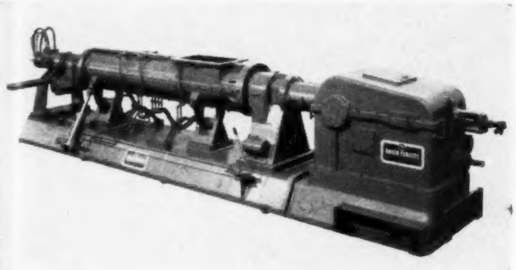
The cathode paste for furnace lining is prepared in two Baker Perkins *Universal* twin-bladed batch mixers, each of which has a capacity of 67 cu. ft. The carbon grist and binder components are metered into each machine and, after a predetermined mixing period, the paste is discharged through two pneumatically operated doors in the base of the mixing trough into wheeled containers for conveyance to the furnace room. The *Hydrotherm* system of heating is again used for raising the temperature of the mass to the required level; other special features include renewable stainless-steel liner plates to resist abrasion; the mixing trough ends are split horizontally to simplify blade and liner maintenance. The 50-h.p. drive system incorporates a hydraulic traction coupling.

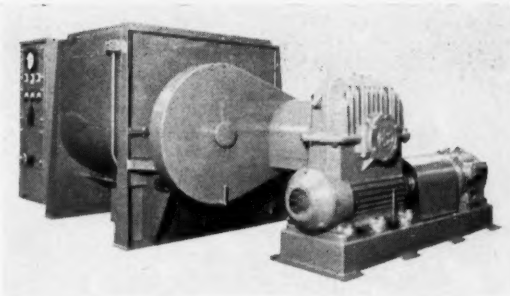
Pitch melting

The hard pitch is delivered in chunks of 12 in. and 16 in. in size, and the pitch melters are charged by means of a skip hoist which has a capacity of approximately 7 to 8 long tons/hr. The melting tanks are provided with internal heating coils and are charged in a cycle so that one melting tank is not in operation, facilitating sludge removal. Each of the three melting tanks has a capacity of 2.6 long tons/hr. For a production of 4 long tons/hr. around 4 million B.Th.U. are required for melting and heating the hard pitch. All three melters are provided with circulating pumps to provide equally heated pitch.

From the melting tanks the pitch is pumped to large holding tanks where it is brought up to its ultimate temperature for use in the preparation of anode paste or lining mixture.

Continuous mixers for producing the anode paste from brown calcined coke and molten pitch were supplied for the Baie Comeau carbon plant by Baker Perkins Inc., of U.S.A., and Canadian Baker Perkins. In this type of mixer, shown below, the screw and kneading chamber jackets are suitable for 150 p.s.i. working pressure, the stroke of the kneading screw is 4 in. and the rated strength of the machine 60 h.p. at 30 r.p.m. screw speed.





Paste for the furnace lining (the 'cathode') of the aluminium plant is mixed in two batch mixers like the one above supplied by Baker Perkins Ltd., Peterborough, England.

Central automatic control

An outstanding feature of the Baie Comeau carbon plant is the high degree of automatic control, the whole of the operational sequence being controlled from a central control room There are three separate control panels for indicating and recording temperature, draught, bin level of storage and fraction bins, pitch level in melting and holding tanks, flow rate and quantity of pitch, grist rate and quantity of grist used for anode paste or lining mixture preparation. For announcing abnormal operational conditions an annunciator panel with an alarm horn has been installed.

A graphic flow sheet has been provided on one of the panels to give the operator visual control.

The whole operation of the plant is divided into groups and selector switches are provided, the position of which determines the sequence or the flow of the material required. Detailed sequence sheets are available for the operator to perform requested operational combinations. Once the setting of the selector switches has been accomplished in accordance with those instructions the machinery or equipment selected for this combination is interlocked and can be started in the above predetermined sequence of the flow. Any failure of one or other of the machines in such a sequence stops all the machinery or equipment ahead of the faulty machine.

Contamination prevented

The grist fraction for both anode paste and furnace lining is prepared with the same handling, screening, crushing and fine-grinding equipment and in order to prevent contamination one with the other, an automatic purge period is introduced before the operator is able to switch from one raw material to another. The dust filtering purge cycle is long enough to clear all chutes and equipment and also clear itself from unwanted material.

Equipment suppliers

The engineering of the carbon plant was undertaken by the Kennedy-Van Saun Mfg. & Eng. Corp., New York, who also manufactured equipment for the material handling system, the air-swept ball mill system, the pitch melter and holding tanks, heat exchanger, briquette-cooling arrangement, crushers, drier installation and feeders. Other companies who were concerned in the equipment of this plant include Baker Perkins Ltd., Peterborough, England (batch mixers); Baker Perkins Inc., U.S.A., and Canadian Baker Perkins Ltd. (continuous mixers); Sweco Co. (screens); American Hydrotherm Corp. (*Hydrotherm* system); and others.

Corrosion Problems in Industry

A memorable and unique event in the history of industry's battle against corrosion was the Corrosion Convention, held in London last October and attended by over 500 delegates from the United Kingdom, Europe and America. Thirteen papers, dealing with different aspects of the corrosion problem, were delivered and discussed over two days, a great number of points of importance to chemical engineers being thrashed out.

Corrosion in the chemical, petroleum, atomic energy, metals, paints, plastics and shipping industries came in for examination, while other subjects of the papers included packaging, water treatment, cathodic protection, fuel additives, hot galvanising and the protection of buried pipes. The Convention was held in conjunction with the Corrosion Exhibition, both events being organised by our associate journal *Corrosion Technology*.

The full proceedings of the Convention are now available and make a valuable addition to the literature of corrosion. Entitled 'Industry Fights Corrosion,' the volume contains the full text of all the papers together with the discussions that followed them. Biographical notes on the authors of the various papers are also included. The volume is illustrated and costs 21s., post free, from *Corrosion Technology*, Leonard Hill House, 9 Eden Street, London, N.W.1.

A CPE Chemical Engineering Review

METALLURGY

By H. A. Holden, M.Sc., A.R.C.S., D.I.C.

Metals in the atomic energy industry; welding developments; aluminium and magnesium; metals in chemical engineering, etc.

THE Russian *Sputniks* and more recently the release of information by the United Kingdom Atomic Energy Authority on the Zero Energy Thermonuclear Assembly (*Zeta*) at Harwell are undoubtedly the two major scientific achievements in the last few months. It is not surprising to find, therefore, that in the period under review the direction of metallurgical effort has tended to be away from such hardy annuals as titanium for aircraft and materials for turbines, etc., and towards metallurgical problems associated with atomic energy and nuclear power projects. A knowledge of metals, and more particularly the 'newer' metals, will become increasingly important for chemical engineers as atomic projects and processes find increasing industrial applications.

Atomic energy

In this connection, Rotherham,[1] who is the Director of Research and Development, U.K. Atomic Energy Authority, Industrial Group, Risley, has drawn attention to some metallurgical problems which are to some extent common to atomic energy and other branches of engineering. Dennis[2] has also reviewed some of the metallurgical aspects of nuclear power production. Metallurgists and chemical engineers alike will appreciate only too well the difficulties associated with the manufacture, virtually 'on site,' of the 130-ft. diameter steel sphere in 1-in.-thick plate for containing the Dounreay fast-fission reactor and the 40-ft. diameter, 70-ft.-long pressure vessels for containing the nuclear core of the Calder Hall reactors. These were welded up from 2-in. plate but with plate thicknesses up to 4 in. at the points of entry of the gas ducting. At the time of construction they were the largest vessels ever made in such plate thicknesses.

Details have also been published of other uses of welding as applied to different units which make up this first atomic power station.[3]

An aluminium protective container is used for the uranium metal fuel in the Windscale piles and magnesium is employed in the Calder Hall reactors. Future reactors will probably require less common metals such as zirconium, beryllium, vanadium or niobium or even possibly molybdenum and tungsten as substitutes for the aluminium or magnesium. Service conditions would probably entail a high neutron flux, high temperatures, high stresses and either liquid or gaseous corrosive environments and a considerable amount of work is in progress to determine the potentialities of these metals for such applications. For example, in one journal alone, papers have appeared during the past 12 months on the effect of neutron irradiation on the mechanical properties of titanium and zirconium[4] and molybdenum and tungsten[5]; a compressive creep test for alpha-uranium under neutron irradiation[6]; and investigations of the plutonium-iron and plutonium thorium series.[7] The Institute of Metals also arranged a symposium in London on 'The Metallurgy of Niobium' at which five papers were presented.[8]

Niobium is of interest for atomic energy purposes because of its high melting point, excellent compatability with uranium, good high-temperature strength and suitable physical and mechanical properties, and the papers dealt with its development, melting point, physical and mechanical properties, purification by sintering and the production and fabrication of massive niobium metal. American information includes details of the technology of beryllium and beryllium oxide,[9] the powder metallurgy of beryllium[10] and the use of thorium as a 'fertile' material in four types of nuclear reactor under construction in the U.S.A.[11]

Materials for atomic energy plant construction have been generally reviewed by Rudiger[12] and Beeghly[13] has given some details of the use of low manganese steels for nuclear applications. Where sources of radioactive isotopes must be kept to a minimum, steels with low manganese contents are stated to be desirable.

Welding

Having referred to welding specifically in connection with the construction of Calder Hall, it is interesting to report that considerable development work has taken place on this particular method of joining.

Leder[14] has published a most useful review of new developments with particular reference to the welding of ferritic steel which covers manual, submerged-arc and gas-shielded methods. Particular items considered include basic covered iron powder electrodes, argon and carbon dioxide shielding and externally fluxed and flux-cored tubular electrodes both with carbon dioxide shielding.

Considerable attention has been paid to the use of carbon dioxide instead of argon or helium and good results are claimed with normal and stainless steels comparable to those obtained from the argon-shielded process.[15] In assessing the merits of the techniques, Mack[16] quotes an instance where it proved advantageous to use argon for shielding the weld of one part of an assembly and carbon dioxide for the other. This was in the manufacture of mild-steel practice bombs where speed of welding, quality and economy accrued from using argon on the longitudinal seams and from carbon dioxide on the circumferential seams. Hazlett and Gordon[17] have reported on arc-welding tests on freshly machined A.I.S.I. 1020 rolled plate $\frac{3}{4}$ in. thick with $\frac{1}{16}$ in. mild steel welding wire (0.15% C and 1% Mn) using straight and reverse polarity and with carbon dioxide, helium and argon atmo-

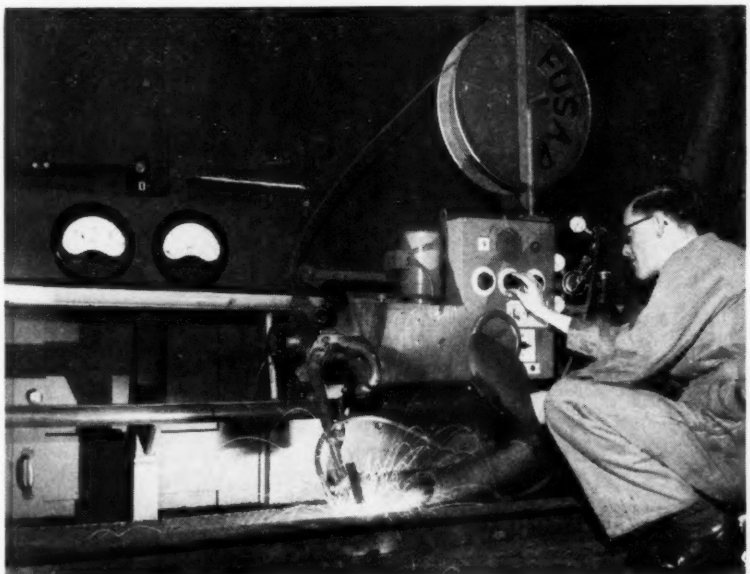
spheres. Similarly van der Willingen and Defize[18] investigated the arc characteristics and behaviour of carbon dioxide as compared with the rare gases. They found that simple arc transfer occurs with carbon dioxide and 2 to 3 vol.% carbon monoxide referred to the carbon dioxide used is lost to the surroundings and this may constitute a possible health hazard. Hydrogen is eliminated and welds with superior mechanical properties and low nitrogen content were obtained. They consider that carbon dioxide is suitable for automatic welding processes. Jahn and Gourd[19] agree with this as a result of their tests on the carbon-dioxide-shielded welding of mild steel. They showed that choice of the most suitable electrode is governed by both the plate material and the mechanical properties required. An increase in spatter and a poor weld bead appearance was found when using carbon dioxide instead of *Argonox* 2 in manual welding. On the other hand, Davis and Telford[20] claim several advantages for a manual carbon-dioxide-shielded arc-welding process for mild steel. This includes a magnetisable flux which when used with a steel welding wire is attracted to the wire where it stabilises the arc, refines and protects the puddle and controls weld contour and coalescence.

Specific processes incorporating carbon dioxide shielding include *Arcosarc*,[21] *Fusarc*,[22, 23] *Unionarc*[24] and *Dual-Shield*.[25] In the first, the a.c./d.c. welding electrode contains slag-forming additions and has a high melting rate and deep penetration; the *Fusarc* process incorporates a rutile flux; and in the *Unionarc* process a continuously fed wire electrode is magnetically coated with flux and it is claimed to be applicable for welding across gaps and seams containing moderate amounts of rust, scale and moisture. Wires of $\frac{3}{32}$-in. and $\frac{3}{64}$-in. diameter are used with a welding current of 350 to 450 and 125 to 250 amp. respectively. Details have been given of a Japanese carbon-dioxide-shielded arc-welding process for steel.[26]

Mention was made above to possible health hazards associated with the formation of carbon monoxide during the carbon dioxide process and methods for the effective control of welding fumes have been reviewed by Nelson.[27] He includes a report of trials to determine required air volumes and velocities and the air-flow resistance of Admiralty standard flexible hose as a guide to fan volume and pressure required in dockyard work. Location and size of hoods are recommended.

Advances in welding electrodes include electrodes coated with 30 to 50% titanium oxide, usually as rutile.[28] High welding speeds with good slag cover of the bead are claimed, coupled with excellent mechanical strength and micro-structure. *Inco-Rod* 'A' is a new welding electrode for joining dissimilar alloy combinations and a series of weld test results have been published.[29] The bulk of the cold-drawn seamless steel tubing made in this country, America or Germany is now drawn, using a zinc phosphate coating to facilitate cold working. Not only does the phosphate coating enable inter-anneals to be eliminated but it reduces die wear, permits faster drawing speeds and improves the surface finish of the drawn tube.

The effect of residual phosphate coating on the strength and ductility of flash welds has been investigated by Young and Phillips.[30] They found that unless the residual phosphate is removed prior to welding, brittle welds of low notch bend strength may result. Lastly, whilst still on this subject, welding technology in the U.S.S.R. has been described[31] and reviewed.[32]



[*Courtesy: Quasi-Arc Ltd.*

A horizontal-vertical fillet weld being made by the 'Fusarc/CO_2' process. This process makes use of a combination of flux and gas shielding.

Aluminium and magnesium

Aluminium and magnesium continue to find increasing applications and attention has rightly been drawn to the way primary production of the former in the United Kingdom has lagged behind fabrication owing to the scarcity of water power. For example, at the end of 1956 the output of fabricated aluminium was over 300,000 tons of which only 30,000 tons was from home-produced primary metal.[33] In contrast, it is anticipated that the U.S. primary aluminium capacity will be more than 2½ million tons p.a. by the end of 1958 with secondary production estimated at approximately 300,000 tons.[34] The fields in which aluminium is making the most rapid strides include shipbuilding, road transport, building and other structural uses. So far the British Railways have been slow to adopt light metal construction but a start has been made with the London Underground.[35] Some of the latest applications for magnesium include tape-recording equipment, teleprinters, electronic equipment and in electric motors advantage is made of its light weight, robustness, non-magnetic properties and low electrical conductivity.[36]

Murphy and Doumas[37] have reported brief but very interesting details of the electrodeposition of aluminium from a solution of aluminium chloride in an amine-ether mixture and information has been published on the *Hardas* process for the hard anodising of aluminium.[38] The coating is claimed to be approxi-

mately three times as wear-resisting as an equivalent ordinary anodic coating and considerably harder than hard Cr plating to which it is comparable in cost. In this process the rate of flow of electrolyte relative to the anode is 70 ft./min./linear ft. of anode surface in the direction of flow with an anode temperature rise of not more than 20°C. within the anode length. All wrought aluminium alloys and most cast alloys can be treated. The usual coating thickness is 2½ to 3 mil. Claimed to be a new aluminised coating,[39] General Motors spray valve faces with aluminium after degreasing and preheating to approximately 230°C. and promote diffusion by heating to some 790°C. by induction. Completely automatic equipment is used and service life tests on treated and untreated valves are quoted.

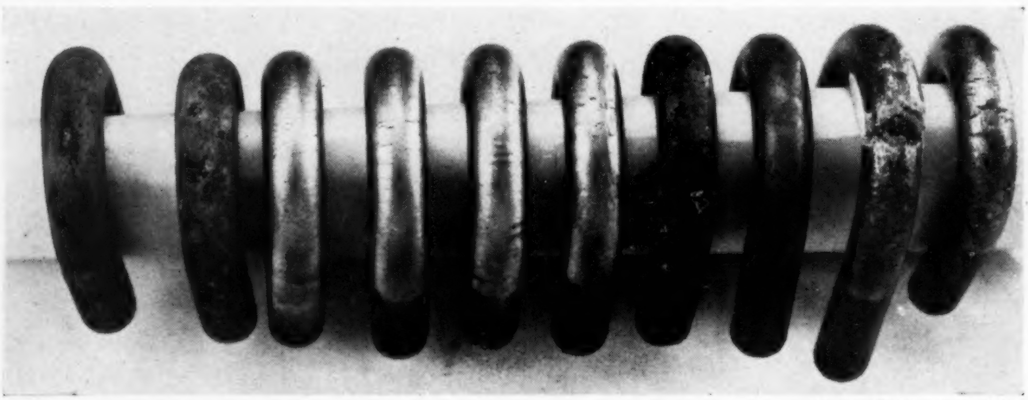
Turning to the finishing of magnesium, the H.A.E. process has been studied by Salmon and Ogburn,[40] who put forward simpler and equally effective sealing treatments than the standard one of immersion for 45 to 60 sec. in a 2% sodium dichromate plus 10% ammonium bifluoride (w/w) solution, air drying without rinsing and heating at 75°C. for 6 to 7 hr. in an oven over an open vessel of water. These are either substitution of a 20 to 40 min. immersion in 2% sodium chromate at 77°C. followed by air drying for the final heat-treatment in the standard procedure or immersion in 2% ammonium dihydrogen phosphate plus 2% sodium chromate solution for 25 to 40 min. at 60 to 80° C. and air drying without rinsing.

Hedges[41] has described the development by the Tin Research Institute of aluminium-tin bearing alloys containing 6 to 21% tin and 1 to 2% copper which combine the good running properties of tin-base bearing metal with the high endurance of leaded bronzes, enabling unhardened steel shafts to be used. Methods of production, cold working and heat treatment are given, together with the results of laboratory and practical running tests on both solid bearings and steel shell facings. The Russians have also announced a new aluminium-based anti-friction alloy having the optimum composition 6% silicon, 4 to 5% tin and aluminium the remainder.[42] The anti-friction properties of aluminium-silicon alloys improve with increase in tin content and approximate to those of Babbitt B83. The mechanical properties of aluminium - silicon - tin alloys are superior to those of B83 and decrease little with rise of temperature. As a result of test bed and service tests it is concluded that the Al-6-4 alloy can be used as a substitute for Babbitts in the bearings of tractor engines. Although not strictly an aluminium alloy, it is perhaps not too much out of context here to mention *Alzen* 305, a zinc alloy containing 30 to 40% aluminium and 5 to 10% copper developed in Austria.[43] Tests suggest that it might well replace bronze except for sea-water application. Complete seizure occurs at approximately 400°C. with little shaft scoring in contrast to bronze or white-metal bearings. Another new bearing alloy which can most conveniently be mentioned here is *Bearium*,[44] of composition 70% copper, 20 to 26% lead, and 4 to 10% tin. It possesses self-lubricating properties and is claimed to have a good resistance to extreme conditions of operation.

New aluminium or magnesium alloys other than those mentioned above include 42B, a high-strength aluminium casting alloy developed for North American Aviation Inc.[45] in which the chief alloying elements are silicon and magnesium with small additions of beryllium and sodium. Its cost is moderately high compared with other aluminium alloys due to its beryllium content, but it is claimed to be economical in practice as it can replace relatively expensive forgings. Pearson and Leontis[46] have given some details of a new magnesium casting alloy with nominal composition 7.6% aluminium, 0.7% zinc, 0.13% manganese, balance magnesium. It is claimed to have favourable casting characteristics with low tendency towards microporosity and to respond well to solution heat treatment. Magnesium-thorium alloys developed for guided missile applications are HK31[47] and HM21XAT8.[48]

Chemical plant applications

Work by Edeleanu and Snowden[49] on the stress corrosion of austenitic stainless steels in steam and hot-water systems is of considerable interest to chemical engineers. These steels are frequently used in plant involving high-temperature water and steam and general service experience is that they are satisfactory except for an occasional case of stress corrosion cracking. It was shown that this type of cracking occurs only under pressure and temperature conditions consistent with the presence of a film of electrolyte on the steel surface, and only if certain impurities such as chloride and caustic are present. Under really bad conditions all the conventional austenitic steel compositions are considered to be susceptible to stress corrosion,

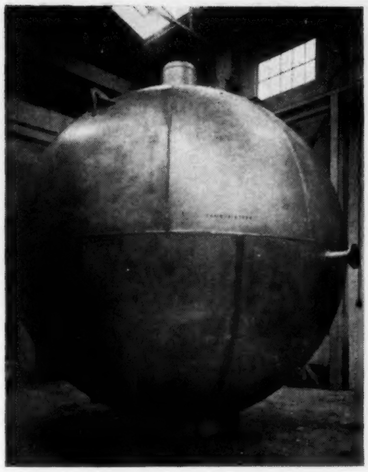


[Courtesy: *J. Iron & Steel Inst.*

A batch of specimens after six months in the drum of a low-pressure boiler, during tests carried out by Edeleanu and Snowden.[49] From left to right the steels were Mo-V, C steel, four austenitic Nb-stabilised stainless steels, a 6% Cr steel, a complex 11% Cr steel, a 14-10 Cr-Ni steel and an 18-18 Cr-Ni steel.

[Courtesy: British Aluminium Co. Ltd.

Above: **A high-test peroxide road tanker/refueller with welded tanks of ⅜-in.-thick B.A. 98% purity plates.**



[Courtesy: London Aluminium Co. Ltd.

Right: **A 'spherical surge vessel' of 14 ft. diam., fabricated in ⅜-in.-thick aluminium alloy. Welding was carried out by the 'Argonarc' process and the vessel was afterwards subjected to rigorous tests.**

although 12% nickel steels may offer a slight advantage under borderline conditions. It was also found that stress corrosion cracking is possible at elevated temperatures in high-pressure air if the steel is contaminated with wet chlorides. The behaviour of 18-8 stainless steel in a range of 2N boiling sulphuric-nitric acid solutions has been investigated by Krystow and Balicki[50]; CD-4MCU is a new high-strength stainless alloy containing 25 to 27% chromium, 4.75 to 6% nickel, 1.75 to 2.25% molybdenum and 2.75 to 3.25% copper, which is claimed to have corrosion resistance equal to that of 18-8 stainless steel with superior mechanical properties[51]; and in view of their light weight, excellent oxidation resistance and high strength at elevated temperatures, *Thermenol* alloys (10 to 18% aluminium, 2 to 4% molybdenum, remainder iron) are also potential competitors for iron-chromium and iron-chromium-nickel alloys.[52]

Turning more specifically to chemical plant. Rabald[53] has published a well documented survey of practical applications in the chemical industry of low- and high-alloy cast irons containing chromium, nickel, silicon and molybdenum either alone or in combination. Pirie[54] has described the use of silver in chemical plant construction and listed its resistance to attack by 18 common reagents under various conditions. It is mainly used as a lining material for handling halogens and halogen acids. In this connection Lingau[55] has prepared a most comprehensive review of the action of hydrogen fluoride and hydrofluoric acid on materials (201 references) and Copson and Cheng[56] have described several case histories showing that *Monel* is susceptible to stress corrosion cracking in moist, aerated hydrogen fluoride vapour but not under conditions of total immersion.

Miscellaneous

A new approach to the forming of high-tensile stainless steels and titanium alloys which present difficulties by conventional methods is the use of explosives. Shaped charges or gases from cartridges force a piston or punch.[57, 58] Ceramic tools are gaining in popularity, particularly in America and Russia[59, 60, 61]; PVC-coated steel is being developed in this country[62] and some American developments have been published[63]; a hard wear-resistant surface has been developed by nitriding chromium castings[64] and *Nivco*[65] is a new high-strength cobalt-nickel alloy.

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PETROLEUM CHEMICALS

—an industry within an industry

THERE is no industry that owes more to the skill of the chemical engineer than the petroleum chemicals industry, which in the United States has been flourishing and expanding for many years past and in Europe has blossomed out with surprising rapidity—born of the search for raw materials other than coal and the need to utilise the increasing quantities of heavy hydrocarbons going to waste at the oil refineries. The increased possibilities of obtaining petrochemicals from new sources of natural gas, as in parts of Italy and France, and the setting up of a special cracking unit within a chemical works, as at the Wilton and Billingham works of I.C.I. in Britain, are interesting departures from the main European trend of setting up petrochemical plants adjacent to the refineries. But whatever the raw material or the approach, the solution of the problems involved in designing, constructing and operating plant for the complicated processes of petrochemical manufacture depended very largely on chemical engineers, who are still steadily improving existing processes as well as developing new ones. Catalytic operations play a key role in the petrochemicals industry and designers are gradually getting to grips with the intricacies of catalysis and putting them to good effect in the newer processes.

Today the petrochemical industry stands, not just as another branch of the chemical industry or of the petroleum industry, but as a unique and exciting field of industrial activity whose boundaries defy definition, but whose products include plastics, synthetic rubber, detergents and synthetic fibres as well as a great variety of chemicals, both organic and inorganic. It is to give our readers an appreciation of the magnitude and scope of this activity that we present the review of petrochemical operations which appears in the following pages.

Europe Heads Towards Self-sufficiency in Petrochemicals

WITH the increase in petroleum refining capacity in Europe the development of the petrochemicals industry has been fast and spectacular and already Europe is beginning to drift away from reliance on American supplies of synthetic rubber, plastics and certain petroleum-based raw materials and intermediates. Although economic conditions for petrochemicals are generally more favourable in the U.S.A., technology is narrowing the gap, while in some places, notably Italy and France, the discovery of supplies of natural gas is helping to accelerate the change.

The latest O.E.E.C. report on 'The Chemical Industry in Europe' indicates the increasing use of natural gas where available, and that the processing of oil fractions to obtain special feedstock for petroleum chemical purposes has continued. Indeed, it seems that this is the beginning of a period when many of the raw materials for the petroleum chemical industry will be specially produced and not obtained from refinery operations as has been the case in the past.

According to the O.E.E.C. experts, the European petroleum chemical industry plans to increase its size (measured by the investment represented by plant in operation) by over 160% inside two-and-a-half years. Leaving aside the United Kingdom, some effects of this expansion in the various countries concerned will be as follows:

In France, some $240 million are expected to be invested in petroleum chemical plant which should come into production before the end of 1959, thus increasing the size of the industry nearly six-fold. Among the projects in this expansion are the manufacture of butyl and S-type rubber, ethylene oxide and derivatives, polythene, alkyl aryls, methanol, secondary butanol and methyl ethyl ketone and aromatics.

Germany also plans petrochemical expansion on a considerable scale. Some $150 million will be spent on plant, expected to come into production before the end of 1959, using as feedstock oil fractions and refinery and natural gas. In other words, the German petroleum chemical industry should more than double its size in terms of investment. Apart from synthetic rubber and polythene, the chemicals to be produced include ethyl alcohol, ethylene glycol, acetone, hydrocyanic acid for polymethacrylate, chlorinated hydrocarbons, and several other chemicals in the solvent and detergent range.

In Italy, new plants at Mantova and Ravenna are expected to come on stream, and $100 million should be spent on the building of three new plants and the expansion of others.

The Netherlands and Belgium also have their petrochemicals projects.

British Petrochemical Developments

By T. H. H. Skeet

Britain's petroleum chemical industry, even now larger than any other in Europe, has expansion plans which, in terms of investment, will nearly double its size over the next two and a half years. This article reviews the activities of the British companies in this field and the developments that lie ahead.

PETROLEUM is the basis of 90% of the total solvent productive capacity of about 110,000 tons p.a. Other new products rival traditional materials such as wood, ceramics and metals in every field. It is impossible to define the ultimate dimensions of the petrochemical industry, which may come to lead British trade and supplant several of the conventional items that head the list of British exports to competitive markets. The peak of activity shifted from the U.S.A. to the U.K. soon after World War 2, and later successive periods of expansion and consolidation followed. The companies concerned were Shell Petroleum Co. Ltd., I.C.I., Petrochemicals Ltd., British Hydrocarbon Chemicals and many others, and the plastics production of the U.K. is now equivalent to 12½% of the world total and stands third after the U.S.A. and Germany. While the export of this product some ten years ago was negligible, the figure for 1956 advanced to 98,000 tons, earning about £26 million of foreign exchange for the U.K.; for 1957 the provisional figure is about £30 million. In the general field of petroleum chemicals 40% of Europe's supply is manufactured in the U.K. Western Germany, primed by a liberal supply of foreign capital, is advancing fast, and both Italy and France are pressing ahead with large-scale development, France in particular, through the aid of a considerable injection of U.S. investment.

New projects

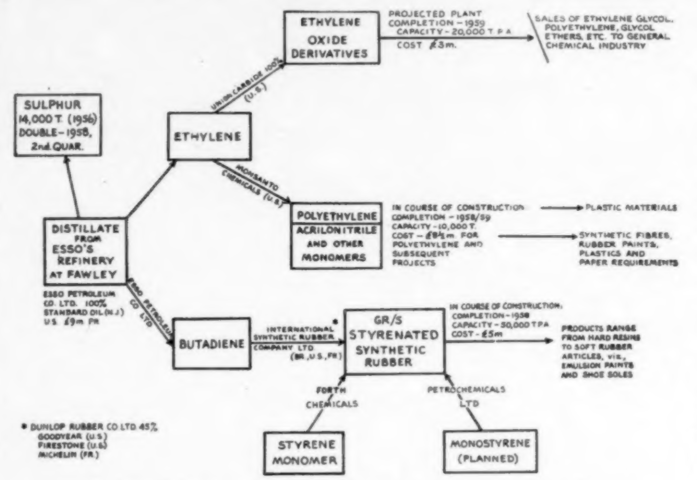
Expansion plans, several of which embrace new and additional plants at Grangemouth, Stanlow, Partington, Fawley, Shell Haven and Wilton, suggest a total investment in the industry by the end of 1958 which is likely to be more than double the mid-1956 figure. It has been estimated that by the end of 1958 the capital allocation for petrochemicals in the U.K. is likely to exceed £100 million.

The advance already recorded by the industry in the United States gives some indication of the likely achievement in the U.K., now that U.S. capital is beginning to flow more rapidly into Western Europe. West European refinery capacity is exceeded

Top right: **The acetone plant at the Billingham works of Imperial Chemical Industries Ltd.**

Bottom right: **Part of the works of Petrochemicals Ltd. at the Partington Industrial Estate, Manchester. At the extreme right is the gas separation plant; centre front, the re-run and azeotropic distillation plant; centre background, the isopropanol plant; and centre left, the stores building and drawing office.**

only by that of North America, and with the additional capacity now under construction or planned immense quantities of feedstock suitable for petrochemicals will become available for new projects that are finding expanding outlets for their products in household ware, emulsion paints and building materials.



Petrochemicals from the distillate at Esso's Fawley refinery.

Chemicals from B.P.

The British Petroleum Co.'s entry into the petroleum chemicals field started in 1947 when British Petroleum Chemicals Ltd. (now British Hydrocarbon Chemicals Ltd.) was formed, in association with the Distillers Co. Ltd., to produce chemicals from petroleum, with a works at Grangemouth in Stirlingshire, Scotland. Both parent companies had previously conducted much research in the petroleum chemical field, and with the complete remodelling and extension of B.P.'s Grangemouth refinery undertaken in the years immediately after the second World War an opportunity was afforded for the development of an all-British petroleum chemicals industry. Today Grangemouth refinery is the central source of raw materials to a number of firms producing a variety of petroleum chemicals. More recently B.P., probably in recognition of the significant growth the company has already achieved in this direction, decided to set up a petroleum chemicals department, distinct from the refining and technical sections. This is a forerunner of the large-scale development anticipated during the next decade. Several companies, held by British and American interests, process intermediates derived from British Hydrocarbon Chemicals Ltd. They include: Monsanto Chemicals Ltd. (two-thirds U.S.A.), Union Carbide Ltd. (U.S.A.), B. F. Goodrich Chemical Co. (U.S.A.) and Forth Chemicals Ltd. (one-third U.S.A.). They are either subsidiaries of large American groups or associated with D.C.L.

The structure as outlined in the U.K. is somewhat similar to that taking shape in Western Germany, where Erdölchemie GmbH., joint enterprise of B.P. and Bayer for the production of petrochemicals, will take their feedstock from the new refinery to be built by B.P. in the Ruhr. The project will cost £20 million. In France, B.P., through Société Française des Pétroles B.P., which holds a 42.8% interest in Naphtachimie, is adding to its petrochemical installations at Lavera, near Marseilles: 48,000 tons p.a. of ethylene and 50,000 tons p.a. of propylene are scheduled to be produced together with ethylene derivatives and butadiene for the manufacture of synthetic rubber.

Esso plans

Esso has hitherto not ventured into the petrochemical industry in the U.K., but now proposes to do so with major extensions at Fawley, Southampton, costing £9 million. Feedstock is to be supplied to three major interests whose plant will be situated in the vicinity of the refinery. Union Carbide Ltd., who are already processing intermediates at Grangemouth, propose to manufacture ethylene oxide derivatives, such as glycol, at Fawley. Next, Monsanto Chemicals Ltd. have a plant under construction and it is scheduled for completion during 1959. Also a new installation is being constructed by the International Synthetic Rubber Co. at Fawley. The company, in which 45% of shares is held by Dunlop, proposes to produce a number of materials ranging from soft rubber to hard resins suitable for shoe soles and the general manufacturing user. Several plants are already manufacturing synthetic rubber in the U.K. at Wilton (I.C.I.), Newport (Monsanto), Birmingham (Dunlop) and Barry (British Geon).

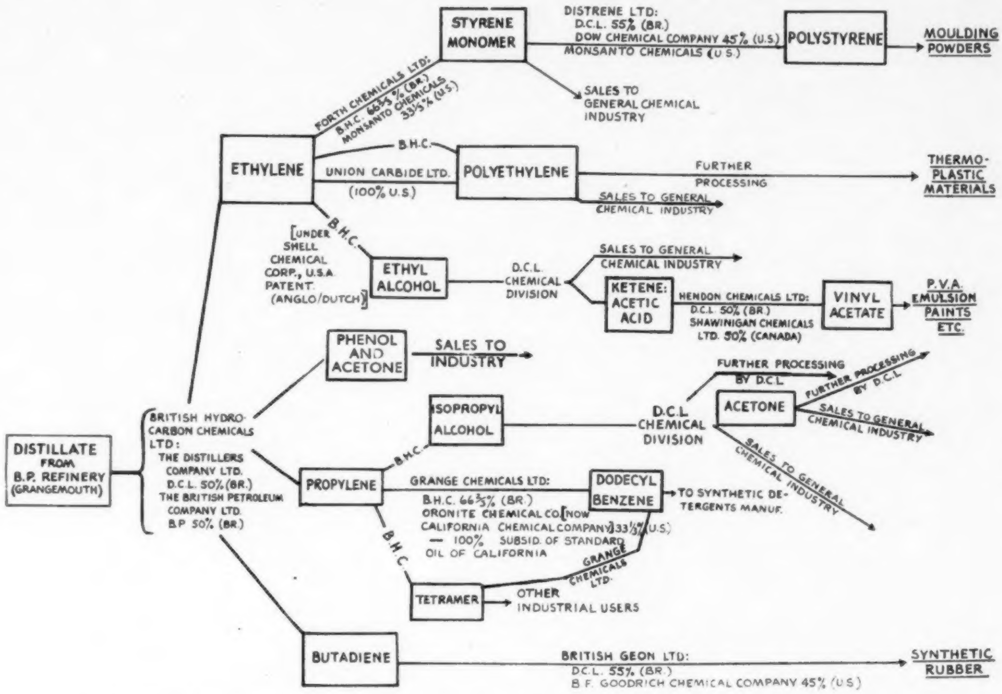
Shell Group

According to Mr. J. G. Loudon, chemicals now contribute about 8% of the total proceeds of the Shell Group, after deduction of sales tax. Until the war, their petrochemical activity was chiefly confined to the U.S.A., but in 1942 the *Teepol* synthetic detergent unit was brought into operation in Stanlow, the first petroleum chemical plant to be built in Western Europe. This was followed by considerable expansion in the U.K. and large-scale production in other Western European countries.

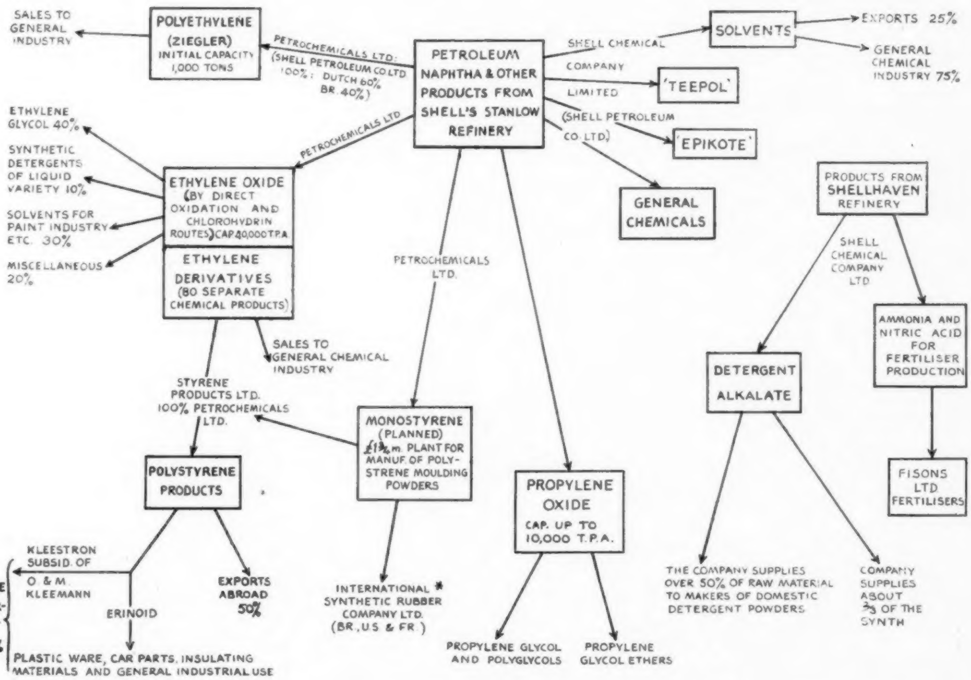
In the U.K., a large chemical solvents plant was completed at Stanlow in 1949, and this has been followed by other plants at the same location for the manufacture of *Epikote* resins, lubricating oil dopes and sulphur. Ethane/ethylene gas is supplied from Stanlow to the Associated Ethyl Co. for use in the production of tetraethyl lead, an anti-knock gasoline additive.

In 1955, Shell acquired Petrochemicals Ltd., a U.K. company operating a special cracking plant at Partington, near Manchester, and later the 40% interest of Erinoid in Styrene Products Ltd. The main products of the Partington plant are ethylene and propylene oxides and their derivatives, and aromatic solvents. A new 25,000 tons p.a. ethylene oxide plant is under construction. In addition, Shell operates a 30,000 tons p.a. detergent alkylate plant at its Shell Haven (Essex) refinery site, and has a 75,000 tons p.a. ammonia plant under construction there from which nitrogenous fertilisers and chemicals will be supplied to the neighbouring plant of Fisons.

A large chemical manufacturing complex has been built up at the Pernis refinery site near Rotterdam.



The company structure dependent on British Petroleum Co. Ltd., Grangemouth refinery.



The petrochemical manufacturing structure dependent on Shell's Stanlow and Shell Haven refineries.

The products now made here include *Teepol*, chemical solvents, *Epikote* resins and PVC plastic, the insecticides aldrin, dieldrin and endrin, sulphur, etc. The only synthetic glycerin plant outside the U.S.A. is now under construction at Pernis. Shell has a majority interest in a Netherlands company, Mekog, which for many years has produced fertilisers on a large scale from coke-oven gas, and has recently added new capacity using petroleum feedstock.

In France, the Group has a 60% interest in Shell/St. Gobain, a company owned jointly with the important French company St. Gobain, which produces *Teepol* at Petit-Couronne, near Rouen, and chemical solvents and *Epikote* resins at Berre, near Marseilles. An extension to the solvents plant and new plants for detergent alkylate and other chemicals are under construction at the latter site.

In Western Germany, Shell and Badische Anilin- und Soda-Fabrik formed Rheinische Olefin Werke (R.O.W.) in equal partnership. This company operates a plant at Wesseling near Cologne with capacities for 10,000 tons p.a. of polythene and 12,000 tons p.a. of ethyl benzene. R.O.W.'s polythene capacity is to be raised to 35,000 tons p.a. by 1959.

The Royal Dutch/Shell Group currently accounts for about one-fifth of the total organic petroleum chemical output in Western Europe, and is the largest single producer of these chemicals in the area. Of this, the Shell Chemical Co. markets some 80 separate chemical products. Already it has ventured into manufacturing polythene by the Ziegler process and has plans for the production of monostyrene which will be sent by rail to the plant of the International Synthetic Rubber Co. for processing into synthetic rubber.

The diagrams on pages 88 and 89 show the pattern of processing by the big U.K. groups. I.C.I., although not refiners of petroleum, have several cracking units and provide raw material for their own petrochemical activities.

Manufacture of Major Thermoplastics in the U.K.

Product and production	Producer	Ownership	Capacity, tons p.a. Existing *Jan.* 1958	Capacity, tons p.a. Announced expansion
POLYTHENE *ca.* 50,000 tons p.a. (1957) Mouldings (*e.g.* household utensils, bottles, etc.), film and foil, pipes and pipe-coatings, electrical insulation, etc.	I.C.I. Ltd. (Wilton)*	British[1]	50,000	40,000 (1959)
	Union Carbide Ltd.* (Grangemouth)	Union Carbide Corp. (U.S.A.) 100%	12,000‡	—
	Monsanto Chemicals Ltd.* (Fawley)	Monsanto Chemicals Ltd. (U.S.A.) 66⅔%; Issued to U.K. public 33⅓%	Nil	11,500 (1959)
	Petrochemicals Ltd.† (Partington)	Shell Petroleum Co. Ltd.[2] 100%	1,000‡	—
	British Hydrocarbon Chemicals† (Grangemouth)	British Petroleum Co. Ltd.[1] 50%; Distillers Co. Ltd.[1] 50%	Nil	11,000 (1959)
		TOTALS	63,000	62,500 (1959)
POLYVINYL CHLORIDE *ca.* 65,000 tons p.a. (1957) Film and sheet, coal conveyor belting, electrical insulation, coated fabrics, flooring material, gramophone records, etc.	I.C.I. Ltd. (Hillhouse)	As above	45,000	10,000 (1958)
	British Geon Ltd. (Barry)	Distillers Co. Ltd.[1] 55%; B. F. Goodrich (U.S.A.) 45%	27,000	—
	Bakelite Ltd. (Aycliffe)	Union Carbide Corp. (U.S.A.) 51%; Issued to U.K. public 49%	6,000	—
		TOTALS	78,000	10,000 (1958)
POLYSTYRENE *ca.* 25,000 tons p.a. (1957) Mouldings (*e.g.* refrigerator, radio and television parts), packaging, household articles, toys, etc. Also foamed material primarily for thermal insulation	Styrene Products Ltd. (Partington)	Shell Petroleum Co. Ltd.[2] (via Petrochemicals Ltd.) 100%	8,000	—
	Monsanto Chemicals Ltd. (Newport)	As above	10,000	—
	Distrene Ltd. (Barry)	Distillers Co. Ltd.[1] 55%; Dow Chemicals Co. (U.S.A.) 45%	7,000	—
	B.X. Plastics Ltd. (Manningtree)	Distillers Co. Ltd.[1] 50%; British Xylonite[1] 50%	4,000	—
	O. and M. Kleeman[3] (Welwyn)	British[1]	3,000	—
		TOTALS	32,000	—
POLYSTYRENE-BUTADIENE COPOLYMERS	I.C.I. Ltd. (Hillhouse)	As above	10,000	—
	Monsanto Chemicals Ltd. (Newport)	As above	Nil	4,000
Synthetic shoe-soling materials, flooring tiles, etc.	British Geon Ltd. (Barry)	As above	Not known	
General-purpose tyre rubbers, *e.g.* for tyres	Dunlop Rubber Co. Ltd. (Birmingham)	British[1]	1,000—1,500	—
	International Synthetic Rubber Co. Ltd. (Fawley)	Dunlop Rubber Co. Ltd.[1] 45%; Consortium of Rubber Processing Cos. (Goodyear, Firestone & Michelin, etc.) 55%	Nil	50,000
		TOTALS	11,000—11,500	54,000

* High pressure processes. † Low pressure processes. ‡ In production.

[1] U.K. Public Company.
[2] 60% Dutch, 40% British.
[3] O. and M. Kleeman discontinued polystyrene manufacture in mid-1957 and have since drawn their polystyrene supplies from Styrene Products Ltd.

Chemicals, Plastics and Rubber from Petroleum at Fawley

ALL ethylene manufacturing processes have three steps: formation; removal of sulphur, water and acetylenes; and separation. For the formation step, there are a number of methods available, including recovery from catalytic cracker gases, coil cracking, steam heat carrier cracking and regenerative refractory cracking. The process to be used at Fawley is a type of coil cracking known as steam cracking. Its characteristics are a coil outlet temperature of 1,400 to 1,500°F., a short residence time at high temperature, steam dilution, and a low hydrocarbon partial pressure at the outlet.

The cracking furnace, the heart of the process, has a radiant section with a high heat density and a convection section in which the charge is vaporised and preheated to about 1,000°F. The cracked products are quenched on leaving the furnace by injecting a cool oil.

Steam cracking produces a variety of by-products in addition to ethylene which, except for the butylenes and butadiene, will be used initially for fuel products.

Butadiene manufacture

Established methods of manufacturing butadiene include: (1) pyrolysis of hydrocarbons as in the coil cracking process; (2) Houdry dehydrogenation of *n*-butane; (3) Esso dehydrogenation of *n*-butylenes; and (4) alcohol dehydration using ethanol as a feedstock. In the Houdry and Esso dehydrogenation processes, the reaction is forced towards dehydrogenation by operating both catalysts at a low hydrocarbon partial pressure. In the Houdry process the catalyst is sensitive to steam and operates under a pressure of 2 or 3 lb. absolute; the Esso process works under a slight positive pressure using steam as a diluent and also as a heat carrier.

Both processes are cyclic in operation, as a portion of the feed is dehydrogenated to carbon which has to be burnt off to reactivate the catalyst. The heat generated during the regeneration cycle provides part of the heat of reaction in the Houdry process and raises steam in the Esso process. Since air is used for regeneration a complicated sequence controller is required in both processes to ensure purging of the reactors after each reaction or regeneration.

The reaction products from dehydrogenation consist mainly of hydrogen, butadiene and unreacted feed. This mixture must be purified to better than 98% butadiene before being used for synthetic rubber manufacture. Such purity cannot be obtained by simple distillation and an extraction or extractive distillation process is required to produce the finished butadiene. The process to be used at Fawley is solvent extraction using a cuprous ammonium acetate solution as a solvent.

The dilute butadiene enters a mixer-settler train and flows countercurrent to the solvent which selectively extracts the butadiene. The optimum extraction conditions are obtained below ambient temperature and the solvent is therefore refrigerated before it enters the mixer-settlers. Reflux to the mixer-settler train is obtained by heating the final settler and thus desorbing some of the dissolved butadiene.

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Plastics

The foregoing details of the ethylene and butadiene manufacturing processes to be used at Fawley were given by Mr. J. A. L. Spiers, B.SC. (Esso), at a symposium held by the Institute of Petroleum in conjunction with the Plastics Institute and the Institute of the Rubber Industry. Plastics manufacture was discussed by Mr. K. C. Bryant, M.A., M.SC., of Monsanto Chemicals Ltd., who pointed out that with the bulk polymerisation process—the oldest technique, which occurs in several forms—the chief difficulty is always to control the temperature rises caused by the heat of polymerisation in a viscous reaction mass. Local economics and the properties required determine which variation of the bulk process is used. This type of polymerisation has rather poor control of molecular weight, but gives good clarity although volatiles may be troublesome. Conversely, suspension polymerisation is readily controlled, but water removal is difficult.

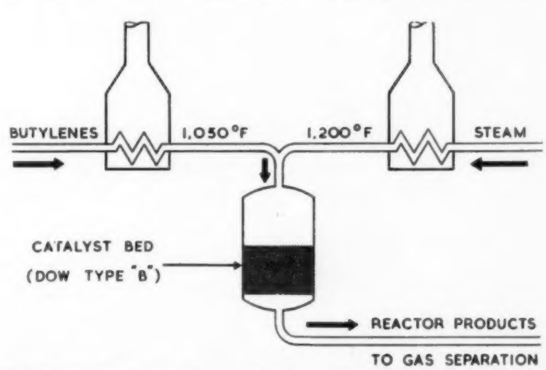
Other polymerisation processes include emulsion polymerisation and heterogeneous catalysis.

On the subject of PVC, Mr. Bryant remarked that its greatest merits are chemical resistance (particularly to hydrocarbons) and lack of flammability; its greatest defect is thermal instability, which causes processing difficulties. Despite these, it is widely used for rigid piping, corrosion-resistant ducts, vessels, hoods and chemical equipment. Rigid sheet is now being used as a vacuum-forming material.

Polythene

In the high-pressure polythene process to be used by Monsanto at Fawley, the main engineering problem is removal of the high heat of polymerisation (800 to 1,000 cal./g., compared with 164 for polystyrene) from a system of poor heat-transfer characteristics. If the heat is not conducted away, the temperature rises, the reaction accelerates, and the temperature rapidly reached a point where the exothermic decomposition of ethylene sets in, and the system goes out of control.

This high-pressure process has enormous flexibility because an extensive range of molecular weights can be



Simplified flow diagram of Esso Engineering dehydrogenation process.

obtained and it has been demonstrated that the density range is much wider than had previously been thought.

With low-pressure processes, Mr. Bryant pointed out, despite the attractive nature of the materials involved and the essentially simple process, the prices may exceed that of conventional high-pressure polythene. This presumably arises in part from the importance of removing traces of the catalyst and solvent.

Piping is an increasing field of application for polythene, but the manufacturers of high-density polythene are now dissociating themselves from the suggestion that their products are suitable for hot-water piping, although they are, of course, quite suitable for cold water if properly fabricated.

Synthetic rubber

To complete the picture of the various major projects in the petrochemical field which are currently under construction in the Fawley area, Mr. K. G. Burridge, M.A., M.SC., A.M.CH.E., of the International Synthetic Rubber Co., gave an account of the manufacture of GR-S rubber, of which some 50,000 tons p.a. will be manufactured near Fawley by the copolymerisation of butadiene and styrene. The other major raw material required is a heavy mineral oil known in the synthetic rubber industry as an oil extender. The use of this is concerned with a later stage of the process. Oil extenders, when added to very high-weight molecular rubbers, act rather like plasticisers for the rubber during fabrication operations in the rubber factory.

In the plant being erected for International Synthetic Rubber at Hythe a considerable part of the plant is reminiscent of refinery operations, except that much of it is contained within buildings with only the butadiene and styrene tank farms, the miscellaneous-chemicals tank farm, and the recovery area equipment are outside. The polymerisation plant is designed for continuous operation and comprises two trains of reactors in parallel; its overall capacity is 50,000 tons p.a. of copolymer. Each reactor comprises a vertical vessel of about 4,200 Imp.gal. capacity with internal cooling coils and a central stirrer, and the polymerisation charge mixture passes in series from one vessel to another from beginning to end of the train. The butadiene recovery operation is accomplished in horizontal cylindrical vessels maintained at a suitably low pressure and through which the latex flows continuously. The vacuum stream distillation operation for removal of unreacted styrene takes place in perforated plate columns, the latex passing down and the steam passing up the column.

Latex is coagulated in vigorously stirred tanks and the crumb is removed from the aqueous medium during its passage across a vibrating screen. After the washing operation the wash water is removed from the crumb *via* a rotary vacuum filter. This causes aggregation of the crumb, which then has to be broken down again in a disintegrator before passage to the drying ovens. These are conveyor driers having three tiers, the rubber entering at the top conveyor and being discharged from the bottom conveyor. The dried rubber crumb is then baled in hydraulic presses and packed either in a plastic film or a suitably coated paper bag.

$25-million Petrochemicals Plant for Canada

Intended to convert the petroleum gas concentrates from three neighbouring refineries into ethylene oxide, ethylene glycol, other ethylene oxide derivatives and polythene, a new $25-million plant has been placed on stream at Montreal East by Union Carbide Canada Ltd., a subsidiary of Union Carbide Corporation of New York, and is being operated by the Canadian company's carbide chemicals division.

Piped from the refineries, the raw gas is put through a number of processes, including absorption, distillation, drying, liquefaction and purification. By-products from the gas purification process include several gases that Carbide use for fuel, while acetylene is being piped to the adjoining plant of Linde Air Products Co., another of Union Carbide's divisions. Acid gases, including hydrogen sulphide, will be piped by Carbide to Laurentide Chemicals & Sulphur Ltd., who will recover elemental sulphur in a plant that will be the first of its kind in eastern Canada. The unused portion of the raw gases is returned to the oil refineries.

After refining, the ethylene oxide from the gases is despatched for use in industry or is converted at Montreal East into the variety of chemicals produced at the Carbide plant. Other raw materials used in these processes include ammonia, alcohol, acetic acid, methanol, butanol and catalysts. Some 640 pneumatic and electronic instruments, 500 control valves and 300 recording instruments are used to obtain precise control over the plant's processes and about 440 men and women are employed there. An IBM650 electronic computer was used rapidly to determine the most efficient combination of the pressure, temperature, flow rate, concentration, etc., variables used for the chemical reaction of ethylene and air over a silver catalyst to produce the ethylene oxide primary product.

The flexibility of the plant enables small 'tailor-made' quantities of specialised chemicals to be produced.

The engineering and design for the project was undertaken by Carbide's own staff, while the general contractors were Angus Robertson Co. Ltd. and Foundation Co. of Canada Ltd.

Petrochemicals and Aromatics in the U.S.A.

In the United States the annual rate of spending for new plants in the field of petrochemicals over the next ten years is expected to far exceed that for oil refining. Capital expenditure on petrochemicals and oil refining are about equal at present. In 1960 it is expected that the annual rate of capital spending for new equipment and plants in oil refining will be some $1,100 million and will increase to $1,500 million p.a. by 1967.

These figures are given by Mr. H. G. McGrath of the M. W. Kellogg Co., New York, according to whom the most outstanding development in petroleum refining in the past ten years has been the synthesis of aromatics on an enormous scale for gasoline. In a paper to the 30th Congrès International de Chimie Industrielle, in Athens, Mr. McGrath pointed out that the greatest single factor in the rise in octane number of gasoline in recent years has been the almost universal use of the hydroforming or catalytic reforming process. Over $1\frac{1}{4}$ million bbl. of inferior-quality naphthas are being catalytically reformed every day in the U.S.A. to make superior-quality gasoline.

The future demand for aromatics in the U.S.A. may become so great that it will be necessary to synthesise benzene and toluene from *n*-hexane and *n*-heptane. In this event modifications of molybdena-alumina or chromia-alumina catalysts may be required instead of the platinum catalyst used principally in current processes.

THE ART OF CHEMICAL PLANT MANAGEMENT-2

By F. Roberts, B.Sc., A.M.I.Chem.E.

The first part of this article, in January, dealt with works organisation, the control of staff and routine organisation. The present article is mainly concerned with the problem of reducing operating costs, but also contains a discussion on accident prevention.

IN many chemical works it is a quarterly practice to work out the cost of production for each commodity in £ per unit of production. The unit selected may be a ton, 1,000 gal, or perhaps a kilogramme, depending upon the scale of operations. A typical cost sheet is shown in the accompanying panel.

The plant manager cannot directly influence the 'works overheads' charge, and so he concentrates on the 'plant cost' of his product. The plant cost may be reduced by increasing *productivity;* that is, by getting a greater output of product from a given amount of effort. Also the plant cost may be improved by tackling individual items in the cost sheet. These will now be discussed in turn. It will be found helpful to plot the quarterly figures graphically, and keep these control charts on display.

		£	%
1. Cost of raw materials, per ton of product		—	—
2. Cost of process labour		—	—
3. Cost of maintenance labour		—	—
4. Analytical charges, per ton of product		—	—
5. Service charges, per ton of product:			
(i) Main workshops, instruments, etc.	—		
(ii) Steam costs, at x shillings/ton	—		
(iii) Compressed air, at y ,,	—		
(iv) A.c. power, at z pence/kva.	—		
(v) D.c. power at m pence/kwh.	—		
(vi) Cooling water, at p pence/1,000 gal.	—		
(vii) Water Board charges, at s pence/1,000 gal.	—		
		—	—
6. Depreciation charges, per ton of product		—	—
7. Special maintenance fund, per ton of product		—	—
Total		£ s. d.	100%
Subtract credit for by-products		—	
Therefore plant cost per ton =		£ s. d.	
Add proportion of works overheads		—	
Therefore works cost per ton =		£ s. d.	

Example of a quarterly cost sheet for a chemical works.

Raw materials

If this item is large—for example, when extracting a product such as uranium from valuable ores—a search for cheaper alternative sources of supply will be made. This is more thoroughly carried out by a central research organisation working in conjunction with the central buying office, but close collaboration will be required from the plant manager in carrying out full-scale trials with sample batches. Some temporary loss of production may have to be accepted, especially since units of the plant will probably need emptying and washing out both before and after carrying out test runs.

Ceaseless efforts should be made to reduce the losses in plant effluents, and also residual losses in vessels when shutting down the plant.

Process labour

The overall efficiency of the process may be improved by a reorganisation of the duties of each man, resulting in lower man-hour charges per unit of throughput. Many firms have instituted work study departments, which have in no small measure caused an increase in production efficiency, or productivity, by the application of the principles of time study and motion study. Workers have benefited from many of these schemes, as their earning powers have been increased by the introduction of bonus schemes.

Careful training of workers is of paramount importance, since chemical process operatives are usually drawn from reserves of 'unskilled labour,' *i.e.* men who have only received a minimum of education and have not been apprenticed to one of the skilled trades. Some large organisations have set up process worker training courses, and all plant managers are well advised to co-operate with their company's administration by releasing their men to attend courses, despite the fact that some inconvenience may result in attempting to arrange for substitutes to keep the plant going. In addition to increasing productivity, a pool of properly trained process labour becomes a fruitful source of chargehands and foremen. The incidence of lost-time accidents is also reduced by the careful training of process operators (see below), thus contributing towards an increase in productivity.

A reduction in the amount of process worker effort required is often effected by the introduction of more process controllers. This becomes of increasing importance as wage rates increase. It may be beneficial for managers to attend courses in the subject, although as the number of instruments on the plant increases, so does cost item 5 (i) shown in the specimen cost sheet, owing to the need for increased effort on checking and maintaining such equipment.

Maintenance labour

This item tends to fluctuate considerably from one period to the next, thus making it difficult to study trends. Although this item is directly studied by the plant engineer, the plant

manager will undoubtedly keep a watchful eye on the quarterly figures plotted in graphical form.

Special maintenance fund

It may be asked why there is a separate item of this kind when the cost sheet already includes maintenance labour, workshop services, etc. The real purpose is to put aside a fixed amount to pay for large and expensive maintenance items which, if paid in a single quarter, would make nonsense of the plant cost for that period. For example, the complete re-tubing of the copper calandrias of a multiple-effect evaporation plant would be a maintenance job of this order of magnitude. It can hardly be called a capital expenditure, as the job does not add to the total invested capital of the works. However, it is only reasonable to spread out the paying for large maintenance items of this order in like manner to the way in which capital charges are paid.

Analytical charges

This item can be quite high, especially if the process includes a large number of stages in which costly reagents are employed. The latter may have to be made up to various levels of concentration or purified to varying degrees and all these solutions may need chemical testing before they can be fed into the main process stream. Analytical costs can often be reduced by the introduction of simplified tests which can be carried out on the plant by trained process personnel. Processing time may also be reduced when samples can be analysed on the job. Many process worker training schools (see above) teach simple laboratory techniques such as the pipetting and titrating of solutions, the use of hydrometers, and simple comparator testing.

Service charges

A variety of sub-items figure under this main heading, and the relative importance of these will vary considerably from one process to another.

When evaporation and condensation processes are involved, steam costs will invariably constitute a large percentage of the plant cost. A variety of literature on the saving of process steam has been published by the Ministry of Fuel and Power, and such a work as 'The Efficient Utilisation of Steam' by Oliver Lyle is sufficiently comprehensive and practical to warrant a place on the plant manager's bookshelf. Occasional reference to this literature will serve to stimulate ideas from both plant engineer and plant manager.

In electro-chemical processes, d.c. power is usually the major charge and, in fact, a source of cheap hydro-electric power is often sufficient reason alone for the location of the works. A large reduction in d.c. costs is often only possible by the development of an improved type of cell, and this may be considered to be outside the scope of a plant manager's terms of reference. Nevertheless, a complete voltage balance throughout the whole busbar system from substation to plant, between individual cells, and whenever possible *within* the cells should be carried out periodically. All electrical connections should be checked frequently for overheating and, if necessary, dismantled, cleaned and re-assembled before oxidation and scaling can increase the electrical resistance and cause damage. The reduction of power consumption within an electrolytic cell is a technical matter outside the scope of the present article.

A.c. power costs are not often high in conventional chemical plants, but there is usually room for some saving to be made after a critical consideration of such items as the amount of cooling water circulated, the operation of pumps and blowers generally; even a saving in electric lighting may be brought about by the introduction of more windows. (The last item may also help in the interests of safety, although it may cause a slight increase in space heating charges if a process is being operated where there is no appreciable loss of heat to the surroundings.) It is well to remember that cheap night rates are sometimes possible, and a little rephasing in the programme may allow for a better use of this factor.

Depreciation charges

In general, this item is outside a plant manager's control. However, schemes for introducing improvements in productivity may sometimes involve capital expenditure and, in this case, item 6 on the cost sheet will undoubtedly be increased. If a capital expenditure proposal is made, this will be done formally in writing, showing the total estimated cost of the scheme and also the expected annual saving in plant costs. The statement should be concise, and will generally finish up by indicating how long it will take to recover the capital cost of the job. Proposals of this nature have to be sanctioned by a committee, depending upon the sum of money involved, and preliminary discussions between the plant manager and his seniors will be useful in gaining their backing before the committee stage is reached.

The *plant cost* of the product is obtained by summing the seven main items on the cost sheet and deducting any credit allowed for by-products or residues which may be sent to neighbouring plants for working up or for purification. A fixed proportion of works overheads is then added to give the *works cost*. In a very large organisation, the company will have to add on further overheads to cover the cost of maintaining research departments, sales and technical services, headquarters organisation and so on. Hence the gross cost of production may bear very little relationship to the plant cost of producing a chemical commodity, but it is only the latter value with which the plant manager is directly concerned. As an executive in the company, he can, of course, help to keep works overheads low by exercising economy in the use of stationery, typing services, factory transport, etc.

ACCIDENT PREVENTION

Accident prevention—'safety'—is the fundamental responsibility of the plant manager, not the works safety officer. The latter official is only empowered to act in an advisory capacity throughout the works. The author once attended a management training course at which the chairman summed up the first session by saying, 'Plant managers in this organisation will not get medals for increasing production and lowering costs if in doing so they kill or maim their process operators.' Senior management in chemical works and research departments often find difficulty in arousing an interest in safety matters among junior graduate staff. 'Safety consciousness' only seems to come when the professional chemist or engineer is fully mature. However, staff are not selected for promotion to the higher ranks unless and until their superiors feel confident that a high sense of responsibility towards *all* aspects of the job, including safety, has been reached.

Many junior plant managers have been found lacking in their knowledge of the statutory regulations concerning factories—that is, the Factory Acts. It would be tedious in the extreme to attempt to read these through, but it is useful to keep a copy of Redgrave's Factory Acts handy in the office for frequent reference. The Acts decree that 'The Chemical Works Regula-

(*Concluded on page* 100)

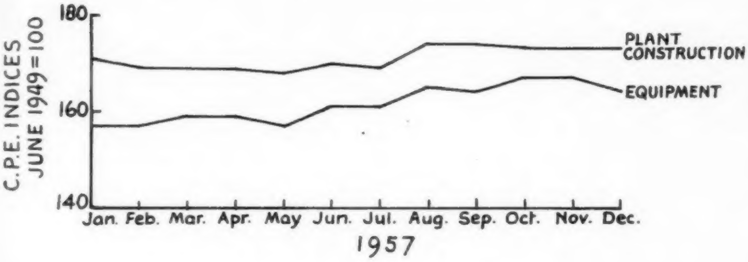
Which Way Will Chemical Plant Costs Go Now?

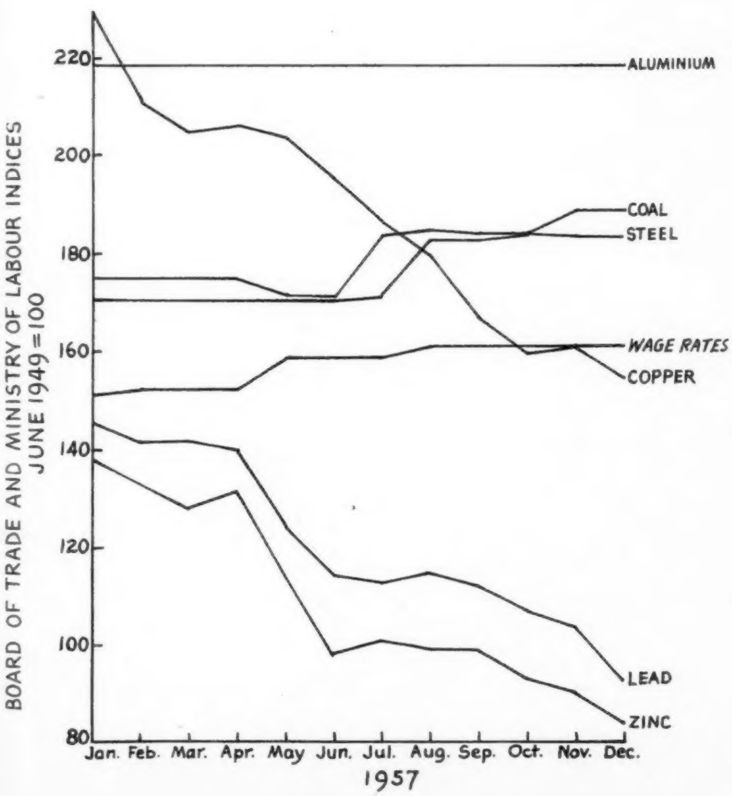
AT-A-GLANCE SUMMARY OF C.P.E. COST DATA

IMPORTANT NOTE: From now on, monthly indices will be published only 2 months in arrears instead of 3 months as previously. This month, therefore, we give figures for both December 1957 and January 1958 as follows:

Plant Construction Index . . . December, 172.7; January, 172.3
Equipment Cost Index . . . . . December, 163.7; January, 163.5

GRAPHICAL SUMMARY OF COST TRENDS, 1957





WITH the figures for December now available, we are able to summarise our monthly Equipment Cost Index and Plant Construction Index for 1957 as in the table below. In neither case is the rise remarkable nor as high as might be expected.

In June, coal prices rose sharply, following on the rise in wages earlier in the year, and this had the inevitable effect of causing steel prices to rise almost as steeply a month later. The increased cost of steel was not without its effect on the cost of plant construction and on the cost of equipment. The graphs show clearly how one rise follows another. The rises in costs in the chemical industry have been moderated by the falling prices of the non-ferrous metals—copper, lead and zinc. Both aluminium and nickel costs have remained constant throughout the year.

Towards the end of the year coal again rose in price, while the non-ferrous metals declined more rapidly. If the increased cost of coal is without effect on the cost of steel, the indices for the chemical industry should show a downward trend in the early part of 1958. (The equipment index shows this trend in December 1957.) Further wage increases in the spring may initiate a fresh upward movement all round.

	Plant Construction Index	Equipment Cost Index
January	170.5	157.3
February	169.3	157.1
March	168.7	158.7
April	169.2	158.7
May	167.8	156.9
June	169.7	160.6
July	169.4	160.6
August	173.7	164.7
September	173.6	163.7
October	173.2	166.5
November	173.2	166.5
December	172.7	163.7

WORK STUDY
in the Design of Chemical Plants

By E. H. Salisbury

(Chief Engineer's Department, Billingham Division, Imperial Chemical Industries Ltd.)

At a conference of the British Institute of Management in London on February 6, the author presented a paper dealing with the application of work study methods to the design of chemical plants, and giving as an example the steps which ideally should be followed in the design of a chemical factory on a 'green field' site. This article comprises extracts from the paper.

THE fundamental requirement in the design of plant is to ensure the supply of product in the required quantity to the correct specification and at minimum cost. Major factors which must be considered are choice of process, its capital cost, and the highest productivity it is possible to achieve by the personnel responsible for the operation and the maintenance of the plant. Much will depend on good overall and detailed layout of the plant.

The application of work study techniques during the whole process of design, commencing in the research and pilot-plant stages, can have a profound influence in achieving these objectives.

Research and pilot-plant stage

It is assumed that the nature and amount of the final product from the proposed new factory are known, together with the basic process which will probably be employed.

The research stage involves the intensive study of the basic process and possible variations in it, helped by the application of the powerful work study techniques involving the critical questioning sequence. Those who are to be responsible for the design and layout of the final plant should closely be associated with all work arising from the research and subsequent stages.

Alternatively processes may have to be examined in some detail with the object of ensuring that the final choice results in a minimum cost of product. Capital cost estimates made by the engineering department will also be necessary before a final decision can be made, based on the 'economics' of two or more possible processes.

A process may be so novel, involving also special metallurgical and engineering problems, that it may be deemed wise to proceed with the building of a pilot plant before attempting to proceed with the final flowsheets. The design of the plant should be considered in some detail by the engineering and research departments to ensure that data sufficient for the solution of outstanding problems will be forthcoming. Metallurgical and other specialists should be consulted as occasion demands.

Process-development (flowsheet) stage

On conclusion of the research and pilot-plant work the preparation of the final flowsheets for the new factory may proceed. These are generally prepared in outline giving the main process steps only, and the recommended equipment. In this form the flowsheets reach the engineering department, whose responsibility is now to translate them into fully detailed engineering designs.

It should be mentioned here that some major new projects may be very similar—or even 'repeats'—of plants already in operation and the flowsheets would be based on these known processes. In such a case the critical questioning sequence based on flow process charts should be carried out before the final flowsheets are prepared. There must be very few processes which cannot be improved in the light of new knowledge and critical study. An examination of the costs of production and of maintenance of similar existing plants will often indicate those links in the production chain on which critical study should be concentrated, and which occasionally will yield spectacular results.

One major consideration at the flowsheet stage—and later in more detail during the final design stage—is that of maintenance. As process control becomes progressively more concentrated in the hands of fewer process operatives due to the growth of 'automation,' the ratio of maintenance labour to process labour will increase. There are many plants where the maintenance labour is many times that employed to operate the plant. The importance, therefore, of considering these problems early is vital, if one is to achieve the objective of producing a product at minimum cost.

The problems involved will generally be of a nature requiring close collaboration with plant work-study officers.

An example of the type of problem which arises is the necessity to clean plant and associated pipelines at some regular frequency, in some cases measured in days. The layout of the plant involving facilities for rapid dismantling and cleaning is a problem most amenable to solution by work study techniques.

Problem of communication

Methods of passing information and the speed of communication between all concerned can be a major factor in the building of a well-designed plant within the programmed time. The whole subject is most amenable to method study and a description of one such study in a major design organisation may be of interest. With the full knowledge and co-operation of all concerned a study of present methods was instituted involving the technique of random observation. The study involved activities under many headings such as 'drawing,' 'drawing alterations,' 'calculations,' 'correspondence,' 'obtaining and supplying of information,' 'preparation of technical data,' and so on.

A random observation study may be defined as a series of instantaneous observations taken at random on the group or groups being surveyed. If sufficient observations are taken, that is, if the sample is large enough, the percentage of observations is a measure of the proportion of time during which a particular activity occurs.

In the study referred to, the period of survey was not fixed at the commencement, but by examining the data as it became available it was found possible to stop the study after a period of 12 weeks. As a check it was decided to include in the list of activities 'holidays' and 'sickness,' and the percentages of these two items as obtained in the random survey agreed very closely with the actual percentages. The results of the survey were startling, indicating that a considerable percentage of available time was expended in 'obtaining and supplying of information.' Improvement in methods arising from this survey is currently receiving much attention.

One major development arising from the above considerations is the rapidly increasing use of models.

The beneficial effect of rapid communication at all stages between all contributing departments and sections thereof is perhaps the greatest overall advantage flowing from the adoption of model techniques. The contribution and sifting of ideas at an early stage before design work commences, helped by experienced staff not immediately associated with the design process, can be most stimulating and sound suggestions can be incorporated before it is too late. All departments, therefore, are brought together early as a really effective team, with all the advantages that must flow from this.

Factory layout

The layout of the constituent parts of a chemical factory is a fascinating process. It is not essential to know accurately the overall dimensions of each constituent part, but some estimate must be made before the main layout can proceed.

Most designers will often resort to paper 'cut-outs,' each of which represents in plan the area of a structure, building, workshop, office, etc. Others prefer to use three-dimensional models to scale, which may be placed on a gridded base board and on which may be drawn roads, railways, pipe trenches, underground services, drains, etc.

Such three-dimensional models are extremely cheap to make out of, say, cardboard tubing, tins, boxes, and other material normally regarded as scrap. With the aid of these simple constructions such features as the grouping of like sections together, the flow of services, the location of workshops, maintenance facilities, stores and plant offices, can quickly be established. All interested personnel would meet round the model and important comments would be noted on the spot.

Work study can play a most important part at this stage and probably two or more layouts would have to be examined in some detail before the final layout can be agreed.

Layout in detail

While the main factory layout is proceeding, the project design team is also busy developing layout in detail. An example of the type of work involved is a multi-storey structure housing a number of equipment pieces on each floor. As in the case of the main factory layout, early comment from members of all interested departments is vital and, as a means of achieving this, the 'plant layout or preliminary' model built roughly to scale (scale $\frac{3}{8}$ or $\frac{1}{2}$ in. to 1 ft.) is much preferred to the time-consuming process of preparing scheme layout drawings of alternative layouts.

The 'plant layout or preliminary' model should be made of components enabling the model to be quickly built and quickly altered. It should also be 'flexible' in three dimensions—perhaps the most important requirement. This type of model is relatively very cheap and may take a number of forms, all having the object of 'positioning in space' the equipment pieces.

At the 'plant layout or preliminary model' stage, work study in more detail related to manning and maintenance problems is most conveniently carried out. Such a study may result in changes in layout, but how much better it is to make alterations before final design work commences than after the plant is built! Anything which eliminates the need for modification after start-up is to be favoured, particularly those which result in a reduction in the manning of the plant. Appreciable savings, too, in such related matters as 'amenities' have followed from critical study at this stage and it is not too late to implement the results of such study in the final design of amenity buildings.

Piping design

In some chemical plants of the type envisaged in this discussion, pipework general arrangement and detail drawings may, in some intricate and complicated processes, absorb some 40 to 50% of the total 'mechanical' design effort.

The piping design model is receiving increasingly more attention both in the United States and in Britain. The value and advantages of building a model to scale, including piping (generally 1 in. diam. and above), valves, instrument fittings, selected pipe joints, etc., are not obvious and only by using them can their value be assessed.

Planning and progress

When the flowsheets have been received in the engineering department the preparation of project programmes should commence immediately. The great importance of good design planning and progressing is self-evident, and detailed attention to this aspect of project work will be amply repaid in that design and construction work will proceed smoothly. The project engineer, in collaboration with the design and construction staff, should prepare an overall programme resulting in a target completion date for the whole project.

Again the main problem in design planning is the passing of information to the service design sections and others in the shortest possible time, and in the correct sequence. This information may be expressed in the form of multiple activity charts showing, for example, when information should pass from the project section to the structural and civil design sections, bearing in mind that structural and plant erection cannot commence until the foundations are installed.

Much data is available from a study of previous projects and, although no accurate figures can be given, the following serve as an approximate guide.

Taking the time interval between start of final design and completion of the project as 100%, design work should be sensibly complete by 75% of the time, and construction work should start when 25 to 30% of the time has elapsed. Any extension of the design time beyond the 75% mark does not allow adequate time for fabrication and erection of the last major items and, if construction work commences too early, there is a danger of 'over-running' the supply of information emanating from the design sections.

It is stressed that the above percentages serve only as a rough guide, and they will vary with the type of project.

Dealing now with the ordering, progressing and inspection of material, much depends again on collaboration between the project section, service design sections, and

other service sections responsible for procurement of material. It is not proposed to consider these aspects in detail, but perhaps one or two suggestions may be made which may prove of considerable help to the project engineer who exercises overall control. These suggestions again arise from a study of methods of presenting information. The project engineer should not be immersed in detail, but should nevertheless be able to assess quickly the overall position relating to progress of design and procurement of material. Visual aids are very helpful and are much preferred by many project engineers to written methods of presenting information. The engineering line diagrams invariably show all the equipment pieces, piping and associated fittings. A simple colour code conveys information very quickly, *e.g.* a red line marked on the sketch of each equipment piece indicates that the final drawing has been completed; a blue line indicates that the order has been placed; and the amount of cross-hatching, the progress of fabrication. These coloured line diagrams should be located in the section which receives all progress reports, etc., relating to material supply and it is a simple matter to record the information in colour before filing the copy order or progress report concerned.

Another type of visual aid is that employed, for example, to indicate the progress of valves being supplied by a manufacturer. By plotting on a time basis cumulative orders for valves (irrespective of size or pressure standard) and corresponding cumulative deliveries it is easy to see whether rate of delivery satisfies the requirements of the programme. This system does not always provide information in detail, but it enables the project engineer to take action when it is seen that progress is not satisfactory. This system can be extended to steam traps, piping, heat insulation and many other items.

Work study and design time

Occasionally the question is asked ' Does the application of work study principles add to the design time and time required to complete the project ? ' All staff responsible for design in the divisions of I.C.I. with whom the author has consulted are convinced that careful and systematic thought expended at the beginning of a major project will result in a shortening of the design time and in the project being brought into production very much earlier than would otherwise be the case, and with much less fuss and later recrimination.

INDUSTRY REPORTS . . .

Britain's plastics exports

Exports of plastics raw materials from the U.K. set up a new record in 1957. More than 111,800 tons were exported, valued at £29.9 million, representing increases of nearly 14,000 tons and £3¾ million over 1956. The tonnage represents an increase of more than 50% in three years.

In 1957, Australia was again the biggest buyer, with imports valued at over £4 million, and exports to France increased from £1.6 million to over £2 million. The third largest buyer was India, £1.6 million, while for New Zealand, the Netherlands, Sweden and South Africa the values were all over £1.5 million.

These figures are given by the British Plastics Federation, who also reveal that the exported materials consist of moulding powders, resins, sheet, rod, tube, film and foil, but do not include finished products or components.

Petroleum sales higher

Developments of special interest during 1957 mentioned in Shell-Mex & B.P. Ltd.'s recently issued ' 1957 Book of the Year ' include the introduction of the first 10-ton bulk propane vehicle for use by Bottogas Ltd. for delivering gas to industrial plants throughout Britain. Another interesting development was in the supply of fuel oil. Heavy fuel oil is now pumped to the Bromborough and Ince power stations by 6-in. pipeline from Stanlow refinery.

Plastic tubes for Nigeria

The starting up, in July 1957, of a new factory in Ibadan, in West Africa, for the manufacture of plastic tubes was among the developments mentioned by the chairman of the Yorkshire Copper Works Ltd., Col. G. P. Norton, in his annual statement. The plastic tubes are being manufactured for sale in Nigeria by the Nigerian Plastics Co. Ltd., a company recently formed by Yorkshire Copper together with the Western Region of Nigeria Production Development Board and the United Africa Co. Ltd.

Sulphonate soaps plant for M.O.R.

The commissioning of a new plant at Manchester Oil Refinery Ltd., Trafford Park, for the dehydration of sulphonate soaps and the associated recovery of the solvent, has been announced by Petrocarbon Developments Ltd. The plant will ultimately have a capacity of 5,000 tons p.a. of anhydrous sulphonates of a very low residual moisture content.

Although the removal of most of the solvent and water from the initial material presents no undue difficulties and can be carried out by the normal evaporation technique, the removal of the final water remaining in the very viscous residual product presents considerable difficulties both physical and chemical. Petrocarbon state that they have overcome this problem by carrying out a two-stage evaporation with the major evaporative load being taken up in an ordinary evaporation system producing a concentrated material which is then finally dehydrated in a special unit capable of producing an end product with any desired water content without subjecting the material to excessive temperatures. This is an application of a technique previously adopted by Petrocarbon for the evaporation of other thermosensitive materials.

'AH, WILLIAMS, JUST THE MAN I WANT—THERE'S A SWARM OF BEES ON THE OFFICE WINDOW'

Nomogram: How to Estimate Solubility of Water in Hydrocarbons

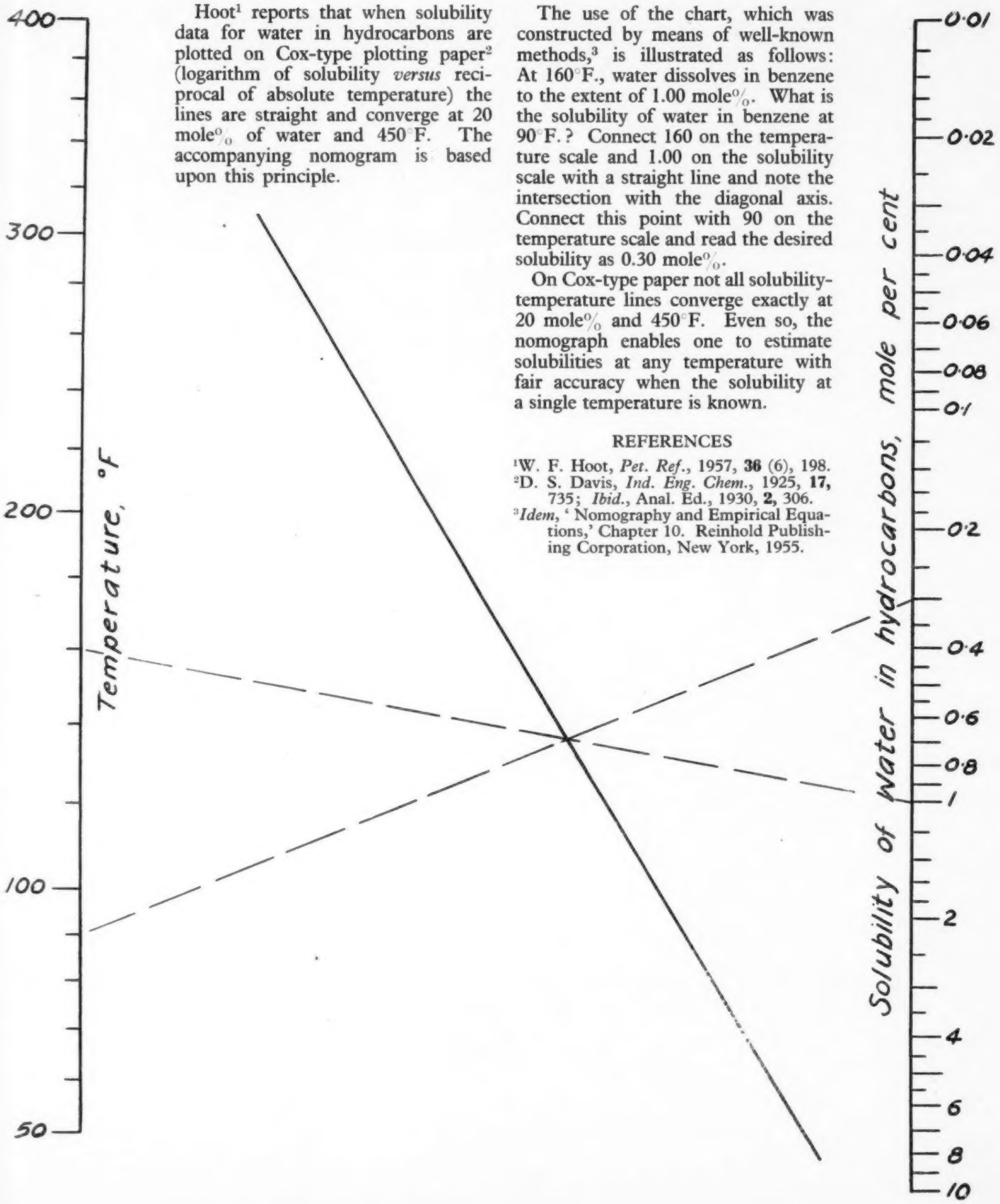
By D. S. Davis

(*Head, Department of Pulp and Paper Technology, University of Alabama*)

Hoot[1] reports that when solubility data for water in hydrocarbons are plotted on Cox-type plotting paper[2] (logarithm of solubility *versus* reciprocal of absolute temperature) the lines are straight and converge at 20 mole% of water and 450°F. The accompanying nomogram is based upon this principle.

The use of the chart, which was constructed by means of well-known methods,[3] is illustrated as follows: At 160°F., water dissolves in benzene to the extent of 1.00 mole%. What is the solubility of water in benzene at 90°F.? Connect 160 on the temperature scale and 1.00 on the solubility scale with a straight line and note the intersection with the diagonal axis. Connect this point with 90 on the temperature scale and read the desired solubility as 0.30 mole%.

On Cox-type paper not all solubility-temperature lines converge exactly at 20 mole% and 450°F. Even so, the nomograph enables one to estimate solubilities at any temperature with fair accuracy when the solubility at a single temperature is known.



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[1]W. F. Hoot, *Pet. Ref.*, 1957, **36** (6), 198.
[2]D. S. Davis, *Ind. Eng. Chem.*, 1925, **17**, 735; *Ibid.*, Anal. Ed., 1930, **2**, 306.
[3]*Idem*, ' Nomography and Empirical Equations,' Chapter 10. Reinhold Publishing Corporation, New York, 1955.

Company News

Q.V.F. Ltd. have assumed the selling agency throughout the U.K. for the glass-lined steel vessels produced by Muller & Co., the Schwelmer Eisenwerk, of Schwelm, Germany. Mr. B. H. Turpin, managing director, states that this development will better enable Q.V.F. to offer a comprehensive service of design and erection of chemical plant in glass, both throughout Britain and abroad. It would also ensure the simultaneous delivery of the entire equipment for any installation.

Another recent announcement from Q.V.F. reveals that within six months the company have increased their exports from 28% to over 40% of their rising turnover. Recent large orders have included plant and material for India, Switzerland, France, Canada and Finland.

*

British Industrial Solvents have announced reductions of £5/ton in the prices of dibutyl phthalate and di-isobutyl phthalate, and of £2 10s./ton in the prices of *Bisoflex* phthalate plasticisers. The new prices for 10-ton spot lots, delivered U.K. in 40- to 45-gal. drums returnable at seller's expense, are: dibutyl phthalate, £222; di-isobutyl phthalate, £204; *Bisoflex* 81, £296 10s.; *Bisoflex* 88, £246 10s.; *Bisoflex* 91, £235 10s.; *Bisoflex* 791, £246 10s. Contract and bulk delivery allowances remain unchanged.

*

Yorkshire Imperial Metals Ltd.—the new company which represents the fusion of the copper and alloy tube, fittings and plate activities of the Yorkshire Copper Works Ltd. and of Imperial Chemical Industries Ltd.—has now been formed.

The new company disposes of assets worth about £18 million, including the former I.C.I. plants at Kirkby (Liverpool), Smethwick (Staffs), Landore (Swansea), and Dundee, and the former Yorkshire Copper plants at Leeds, Barrhead (Glasgow), and Castleford (Yorks). The registered office of Yorkshire Imperial Metals Ltd. is at Haigh Park Road, Leeds.

The board of directors includes, from I.C.I., Dr. James Taylor (chairman), Mr. P. T. Menzies, Dr. Maurice Cook, Mr. M. J. S. Clapham, Mr. St. John Elstub, Mr. H. Royle and Mr. W. N. Ismay; and, from Yorkshire Copper, Mr. G. P. Norton (deputy chairman), Mr. H. F. Sherbourne (managing), Mr. W. R. D. Macdonald, Mr. C. G. Robinson, Mr. D. Fraser, Mr. J. Christie and Mr. C. Breckon. The company's secretary is Mr. P. D. Peel Yates.

*

A branch office that is being opened in Belgium by Evershed & Vignoles Ltd. will be under the management of Mr. C. Samyn and will make the Evershed range of electrical instruments, instrumentation and electronic control equipment available to Belgium, the Belgian Congo and Luxembourg.

The Art of Chemical Plant Management

(*Concluded from page* 94)

tions' must be adhered to in all chemical works, and that a copy of these regulations should be publicly displayed in such works. Perhaps it is unnecessary to say that the plant manager should read them! It will also be found useful to read 'Safety Rules for Use in Chemical Works,' published by the Association of British Chemical Manufacturers.

Many of the minor accidents which occur throughout chemical plants are not peculiar to the chemical industry—for instance, 'foreign body in eye,' 'trapped (or burnt) finger,' 'strained muscle,' 'tripped over,' 'fell down,' 'walked into something,' are accidents common to all industries. The frequency of such common accidents can be reduced considerably by the management's insisting on the use of light eye protection; cotton, asbestos or plastic gloves; proper lifting tackle and the training of operatives in the art of lifting. Also, care should be taken to keep all walkways free from obstruction, well illuminated, and covered with non-slip flooring, at all times. It is only too easy in times of stress to forget the rules of good housekeeping, but the plant manager should develop his 'powers of *safety* observation' so that he becomes automatically vigilant whenever he is on the plant. If a possible hazard is noticed, a supervisor or foreman should be delegated to take instant action.

A plant safety committee should be formed, and its members drawn from all ranks. Meetings would normally be attended by the works safety officer, thus giving him a forum for spreading advice and specialist knowledge in the subject of accident prevention.

The potential large-scale hazards in a chemical process can only be studied and appreciated by those with a background of training, and this is why the plant manager must carry the ultimate responsibility. He is well advised to keep himself up to date concerning knowledge of new hazards previously not appreciated. This he can do by keeping technically and scientifically 'alive,' by keeping in touch with research and development staff and by not hesitating to request a discussion with his area manager or works manager.

Whenever any unusual operation or inspection is being carried out, the plant manager should be present. It is not always necessary for him to direct operations. It is often more convenient to leave this to a subordinate, and thus the manager is free to keep an objective eye on the situation and make any special observation or calculation he may deem necessary.

The Leonard Hill Technical Group—March

Articles appearing in some of our associate journals this month include:

Manufacturing Chemist—Treatment of Glue and Gelatine with Formaldehyde; Veterinary Antibiotic Preparations; Nonionic Surface-active Agents.

Dairy Engineering—New Australian Method of Cheddaring Cheese; Czechoslovakian Developments in Cheese Manufacture; Detergent Recovery Methods; Current Development in Mechanised Cheese Manufacture.

World Crops—Rice Destruction by Crabs; Cereal Production in Britain; Maize in the U.S.A.

Automation Progress—Numerical Control in Action; Reading Machines; Automatic Loading of Multi-spindle Automatics; Programme-controlled Signalling on London's Underground Railways.

Corrosion Technology—The *Serseal* Process for Fume Prevention; O.C.C.A. Exhibition; Corrosion of Type Metal; Application of Plastic Tape to Natural Gas Pipeline.

Fibres—Dyes and Dyeing Techniques; Turbo Dyeing Apparatus; Synthetic Resins in Textile Manufacture, 2; Textile Industry in Israel.

Food Manufacture—Bulk Handling; Problems and Perspectives in Malt Vinegar Brewing.

Paint Manufacture — Specific Surface and Pigment Volume as Factors in Dispersion; Mica in Emulsion Paints; Blushing of Nitrocellulose Lacquers.

Petroleum—Petroleum Development in South America; The Oil Geology of South America; Two Problems in Seismology.

World News

AUSTRALIA

Increased plastics output forecast

Manufacturing activity in the Australian plastics materials industry was maintained at a high level throughout 1957, and this seems likely to continue during 1958, according to a recent survey. The rate of expansion in the consuming industry during recent years has been rather more than 20% a year. Considerable capital is being invested in new and improved plant, and output in 1958 will substantially improve Australia's independence of overseas supplies.

FRANCE

'Eurochemic' hold first meeting

The founders of 'Eurochemic,' the European company for the chemical processing of irradiated fuels, which was set up in Paris last December by 12 member countries of the O.E.E.C., have held their first meeting at the headquarters of the organisation. Chairman of the meeting was Dr. Erich Pohland, of the Federal German Ministry of Atomic Affairs, and the vice-chairman was Dr. Erik Svenke, head of the industrial division of the Swedish atomic energy corporation.

The purpose of the meeting was to take the necessary steps to start forthwith the preparatory work for the construction of the plant and laboratories which the company will operate near the nuclear centre at Mol (Belgium).

It was decided—in agreement with the Belgian centre for nuclear studies, represented by its director-general, Monsieur Louis de Heem—that a first team of specialists to prepare the final plans of the plant and to start the preliminary research would start work immediately at the premises of the Mol centre, which are to be placed at the company's disposal during the initial period.

COLOMBIA

Paper from sugar cane

A spokesman for Grace & Co. has stated that they might eventually contribute $13 million towards the construction of the new paper factory to be built at Yumbo, near Cali, which will give employment to 480 people. The ownership of the factory is to be vested in a company entitled Pulpa y Papeles Colombianos S.A., which was recently founded, and which hopes soon to have a capital of Ps. 34 million. According to the spokesman, the specialised machinery required by the factory would cost $7 million. As raw material the plant will use the remains of sugar cane grown in the Cauca Valley.

UNITED STATES

Ethylene diamine

Commercial output of 98% ethylene diamine is now under way, according to an announcement by the organic chemicals division of Olin Mathieson Chemical Corporation. Ethylene diamine of 85 to 88% and 90 to 93% will still be produced.

Phthalic anhydride

Plans for the construction of a phthalic anhydride plant in Chicago have been announced by the Witco Chemical Co. The plant will be designed and constructed by the Scientific Design Co. Inc. for an annual capacity of 20 million lb. of phthalic anhydride, and completion has been scheduled for early 1959.

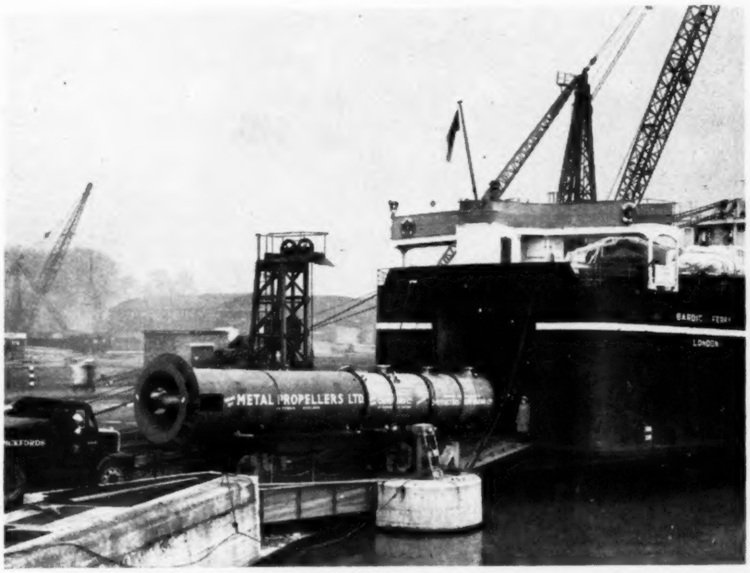
CHINA

Chemical fertiliser

Output of ammonium sulphate in 1957 is estimated at 755,000 tons. The Chinese claim that, when the construction and expansion of eight factories provided for in the first five-year plan is complete, 1,800,000 tons of nitrogenous and 600,000 tons of phosphate fertilisers will be produced. They admit that the development of the fertiliser industry during the last five years has not kept step with the needs of agriculture.

Chemical industry

Work has started on a plant at Taiyuan, in North China, to produce sulphuric and hydrochloric acids, caustic soda, liquid chloride, phenol and indigo as well as '666' and DDT for agricultural use. Annual production of phenol is estimated to be sufficient to make 8,000 tons of the synthetic fibre *Kapron*. Construction of two other plants will be begun in the same district in the spring: a chemical fertiliser plant for ammonium sulphate, etc., and a pharmaceutical plant for various kinds of drugs, including sulpha drugs, and vitamins. All these factories are being designed and built with Soviet assistance.



DISTILLATION COLUMN HEADS FOR NORTHERN IRELAND

Shipment of a 6-ft. diam., 52-ft. long distillation column to Coleraine in Northern Ireland marked an important stage in the building of the new Acrilan acrylic fibre plant of Chemstrand Ltd. at Coleraine. The column is the first of three being built by Metal Propellers Ltd. for the Coleraine plant. It weighs 11 tons, being constructed of stainless steel, and is fitted with Glitsch 'truss-type' bubble trays. In the photograph the column is being loaded on to the Preston/Larne ferry.

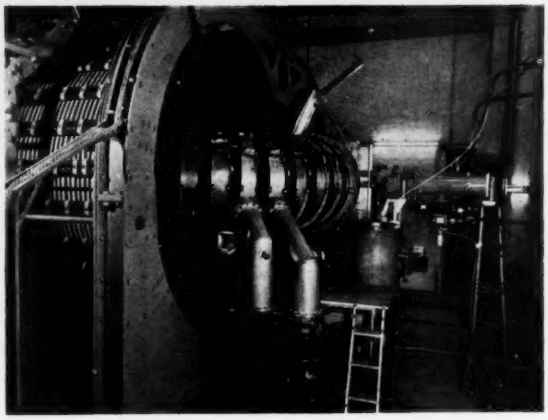
Engineers and constructors for the Chemstrand plant are Constructors John Brown Ltd. The plant is due to be started up in this coming autumn and the capacity of the first stage is estimated to be 10 million lb. p.a.

INDIA

Petroleum possibilities

Agreement has been reached, in principle, between the Government of India and the Burmah Oil Co./Assam Oil Co. to exploit the oil reserves discovered in the Nahorkatiya, Hugrijan and Moran areas of Assam. The agreement involved the construction of pipelines from the oilfields to the proposed refineries and the construction of two new refineries.

The pipelines will be built in two stages. The first will run from the oilfields at Nahorkatiya to a new refinery to be built in Assam, and the second will run from Assam to another refinery at Barauni. The consultants' final report is expected to be ready about the middle of May.



POWER FROM THE H-BOMB

Britain's hopes of cheap and abundant power rest in the 'Zeta' apparatus, discussed on another page this month. The circular torus of 'Zeta' is seen here projecting from the massive transformer coils into which the capacitors discharge 50,000 joules, or 14 kw-hr. of energy.

JORDAN

Dead Sea potash project

The Minister of Economy and chairman of the Arab Potash Co., H. E. Kholousi el Kheiry, has announced that the board has decided in principle on the award of the potash tender to a British firm of consulting engineers, Manderstam & Partners, subject to certain conditions.

Mr. el Kheiry added that the board has authorised Mr. Sami Dajani, manager of the Arab Potash Co., to approach the British firm and to negotiate with it the conditions decided by the board and to request the consultants to delegate an authorised representative to Amman to negotiate the terms of the contract agreement and its signature.

Potash was recovered by the solar evaporation method in Palestine from 1930 until 1948, when one of two plants in Palestine Potash Ltd., at the north end of the Dead Sea, was destroyed. The other plant, located at the south end of the Dead Sea in what is now Israel, has been rehabilitated, modernised, and has been producing potash from brine since mid-1955. Together the two plants were producing an estimated 102,635 tons of fertiliser-grade potassium chloride in 1947.

In rebuilding the north plant, it has been decided to abandon the old process and to adopt whichever one is best suited to present conditions. The first phase is, therefore, to erect and operate a pilot plant in order to obtain the necessary basic data for the design of a full-scale plant. The estimated cost of the final completed factory, when operating, is some £4½-million.

Manderstam report that this is their second recent contract in Jordan. The other is with the Jordan Phosphate Mines Co., for whom they are drawing up recommendations relating to the erection of a superphosphate factory.

GREAT BRITAIN

Non-wettable cement

A cement has been developed which cannot get wet, even when submerged completely in water. Known as *Pectacrete*, it can be left in standard paper bags in wet or extremely humid conditions without afterwards setting solid. In London recently, an agreement was announced between Pectacrete Cement Ltd. and the Rugby Portland Cement Co. Ltd. whereby Rugby Portland have begun to manufacture and market the new cement in bulk.

Pectacrete is the result of a project initiated some eight years ago by Sir John F. Ramsden and Maj. C. L. Walsh, who was assisted by the late Maj. Frederick Webster. In effect, each fine particle of cement is coated during manufacture with a water-repellent chemical, which will remain intact until broken by the abrasive action of mixing with sand or gravel. It is stated that *Pectacrete* is acid-resistant and that concrete made by it is much less water-absorbent than normal concrete.

So effective is this coating that, whereas normal cement increases its weight by 63% after exposure to the atmosphere, *Pectacrete* adds only 5% to its initial weight.

CANADA

Potash project

The International Minerals and Chemical Corporation of Chicago, who are one of the largest potash producers in the United States, have announced plans to spend more than $20 million in the next three years on construction of what is described as 'the most modern and efficient potash mine in the world' at Esterhazy, Saskatchewan.

The mine shaft itself will cost about $4 million. Mining equipment, a refinery, large storage buildings, machine and repair shops and additional plant facilities will account for the rest of the estimated cost.

SPAIN

Raw material shortages

The Barcelona Chemical Syndicate has appealed to the authorities to restrict the opening of new industries owing to the sufficient capacity of existing firms and to raw material shortages. Perfumery industries are suffering from a lack of liquid vaseline imports.

Oil refinery expansion

The capacity of the petroleum refinery at Escombreras, which first came into operation seven years ago, has increased from 250,000 to nearly 3.5 million tons p.a., present figures (in thousands of tons) being as follows: fuel oil, 1,650 (of which part is used in the thermal plant); gas oil, 760; 90 octane petrol, 300; 65 to 80 octane petrol, 300; kerosene, 120; butane and propane, 70; petrol for agricultural uses, 65; fuel for jet aircraft, 60; and lubricants, 32. The 60,000 bbl. of petroleum now refined daily should reach 100,000 bbl. by 1960.

PHILIPPINES

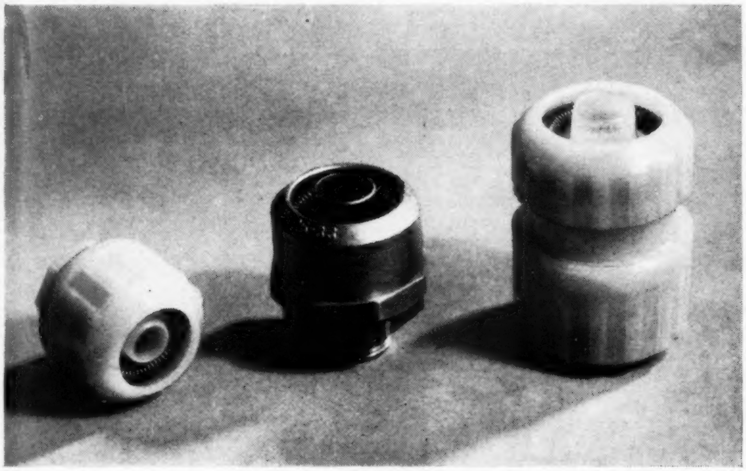
Chemical enterprise

The YSS Laboratories, Manila, in conjunction with other local interests have formed a P3-million corporation known as the International Chemical Industry Inc. and proposes to manufacture various industrial chemicals.

WHAT'S NEWS about

★ Plant
★ Equipment
★ Materials
★ Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).



Hose coupling for use with compressed air and fluids.

Dehydration of air, gas and liquids

Problems created by water vapour concentration in air and gases and by dissolved water in certain organic liquids can be overcome by the use of *Humidryer* equipment which, for continuous drying, incorporates two adsorber towers of activated alumina, one tower being used for drying while the other is being cleared of moisture by a stream of preheated air or process gas. The gas that is being dried is switched from one adsorber to the other at regular intervals by automatic valves, or by the plant operator, on an 8-hr. or other convenient changeover cycle.

In the chemical industry, *Humidryers* operate over a wide range of pressures and flow rates. For instance, air and oxygen for certain oxidation reactions, ethylene for high-pressure synthesis of polythene and acetylene for the manufacture of PVC are dried to prevent unwanted side reactions.

To stop corrosion, dry compressed air is used to displace liquid chlorine from tanks. The use of *Humidryer* dry air breathers in this connection keep out atmospheric moisture from storage tanks containing hygroscopic liquids. Objectionable freezing which would otherwise occur in the production of liquid oxygen, or during the manufacture of solid carbon dioxide, is prevented by dehydration of the gases. It is for a similar reason that gases are often dried before bottling, particularly oxygen for breathing and high-pressure air used in modern aircraft.

Burnett & Lewis Ltd. are the suppliers. **CPE 849**

British aluminium silicate

In our September issue we reported the introduction by Joseph Crosfield & Sons Ltd. of *Microcal* calcium silicate as a white filler for the rubber, paper, plastics and paint industries. The company now announce an aluminium silicate, *Alusil*, which, although of similar millimicron particle size and characteristics to *Microcal*, will be preferable in some applications.

They state that this is the first aluminium silicate of U.K. manufacture to become commercially available. **CPE 850**

Hose coupling

A new hose coupling for use with low- and medium-pressure compressed air and fluids has been announced by Airtech Ltd. The coupling will be of interest to manufacturers and users of pneumatic tools, and to users of compressed air, water, potable and other liquids. The *Free-end* coupling offers the following advantages: it forms a one-piece unit which need never be dismantled; no preparation of the end of the hose is required; no tools are needed for fitting or removing the hose; there are no separate bolts, screws, ferrules, etc.; it is light in weight when manufactured in nylon. **CPE 851**

Metallic borides range

Two series of borides, one of high chemical purity (not less than 99.8%) and the other comprising technical grades of minimum purity of the order of 99%, are announced by Borax Consolidated Ltd. The 11 compounds in the pure series are dense, hard powders of average particle size of 10 to 50 microns, and the 14 in the

C.P.E.'S MONTHLY REPORT AND READER SERVICE

technical series are finer, averaging 5 to 10 microns in particle size.

Several borides of the more important metals such as chromium, molybdenum and tungsten appear either in one or both of the ranges, as well as the borides of some of the less common metals such as titanium, zirconium, vanadium, niobium and tantalum. The high melting points of metallic borides (up to 3,100°C.) and their hardness, make them compounds of major metallurgical interest.

CPE 852

New packing for cooling towers

A new plastic packing for the *Counterflo* cooling tower is claimed to produce a greater cooling surface and an increased flow of heat transfer than is possible with the standard timber grid decks at present in common use. The construction of the new grid is open and the pressure drop low, and the packing permits more water to be cooled or a greater degree of cooling under existing operating conditions.

Head Wrightson Processes Ltd., 24-26 Baltic Street, London, E.C.1, are licensees of the Fluor Products Co., in Great Britain, Europe, throughout the British Commonwealth, excluding Canada, and this new development has patent coverage for the Head Wrightson areas of operation.

Head Wrightson Processes Ltd., who announce the development of this packing by their American associates, Fluor Products Co., of Los Angeles, state that further research has resulted in the development also of asbestos panels for the construction of the tower walls as an alternative to timber panels and off-set louvres which decrease the pressure drop of the air drawn into the tower. Additionally winter operation is improved, as the icing problem formerly associated with louvres adjacent to the tower columns is eliminated. **CPE 853**

Flameproof recorder chart

An electrically driven, flameproof chart unit has been developed by Walker Crosweller & Co. Ltd. for their range of pressure and vacuum, gas flow and effluent flow recorders.

The driving motor is contained in a flameproof housing mounted on top of the recorder case and driven by a vertical shaft at 3 r.p.m. This shaft is fitted with an eccentric which causes a spring-loaded lever to oscillate. The lever is fitted with a pawl which, on the forward stroke, causes a ratchet wheel to advance one tooth. From the ratchet wheel a train of gears conveys the drive to the final shaft which carries a clutch drum for engaging the chart drive roller. Where flow recorders are fitted with an integrator a pair of bevel wheels on the vertical shaft takes off the drive to the integrator. **CPE 854**

BORON COMPOUND

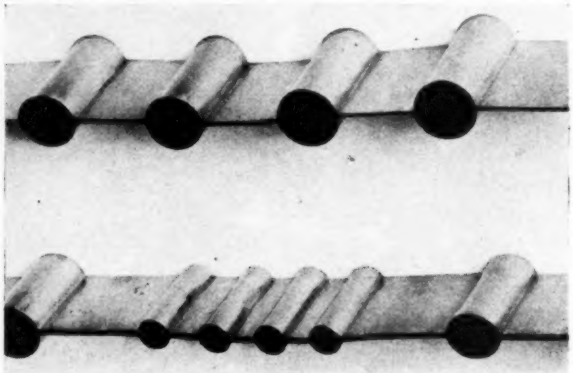
Boron phosphate (BPO_4), a new addition to the Borax Consolidated Ltd. 20 *Mule Team* range of boron compounds, is now available in quantity. Its properties already suggest important potential uses in the preparation of raw glazes and frits for glazing and enamelling processes; and as a catalyst in certain organic reactions **CPE 855**

Analyser for grouped individual samples

A new instrument in the *Analmatic* range produced by Baird & Tatlock Ltd. is designed for those cases where complete automation of the whole process is not required, and also where the individual samples are needed for other purposes after the analytical sequence has been completed and the results recorded.

In this new development, a separate instrument is used for each main stage of the analysis. The instrument automatically functions when an individual tube, or a rack containing a batch of tubes, is slid into position. The rack is then withdrawn and passed in sequence through the remaining units.

Thus a wide variety of analyses can be accommodated by a suitable combination of units, and only semi-skilled operators are needed **CPE 856**



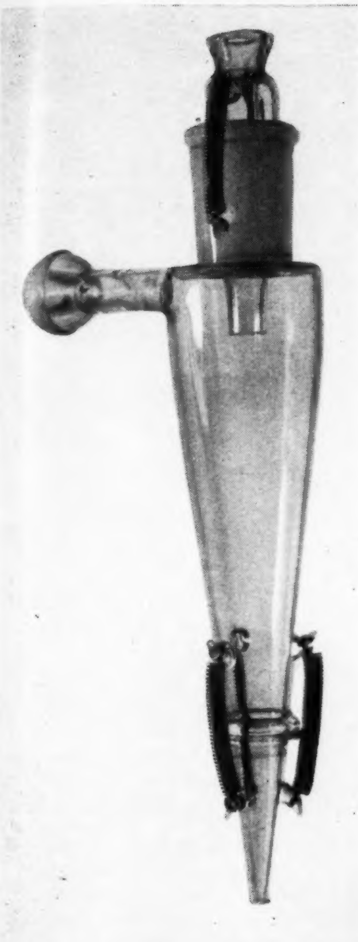
Sections of the inflated 'Tube-in-Strip.'

Heat-exchange element

In a new I.C.I. heat-exchange element, known as *Tube-in-Strip*, a tube or a number of parallel tubes are produced as an integral part of a sheet or strip of metal. During casting, rods of inert non-metallic material are incorporated in the rolling slab. Their position and dimensions determine those of the tubes. In the subsequent rolling they break up into fine powder and elongate with the metal as it increases in length, finishing as a layer of fine powder about 0.001 in. thick within the strip, most of which is removed later. The resulting gaps can be inflated by simple hydraulic or pneumatic pressure by the user, who can beforehand cut the strip to the length desired.

Many applications lie in the field of heat transfer, where the efficient cooling or heating of fluids often requires the use of an extended surface in contact with that fluid which has the lower heat-transfer coefficient. Primary/secondary surface ratios can be varied to meet design requirements. This construction also provides complete isolation of two or more hazardous fluids coupled with uniform heat-transfer conditions. The larger differential surfaces may also be used to advantage in oil heaters and intercoolers.

At present made in copper and aluminium, this design will later include other non-ferrous materials. Range of tube diameters (¼ to 1 in.) will also be expanded. The strip widths are in copper up to 22 in. and in aluminium up to 26 in. The minimum web between tubes is ¼ in. and uninflated *Tube-in-Strip* is available in lengths up to 500 ft. **CPE 857**



'Pyrex' hydrocyclone with precision-ground glass joints.

Liquid-solid cyclone

A laboratory hydrocyclone is available which, owing to the very high centrifugal forces developed, is capable of achieving very fine separations, whilst the very strong shearing forces also present enable these separations to be carried out in pulps of relatively high solid concentration or plasticity. For this reason they are particularly effective in such operations as desliming and de-gritting, as these strong shearing forces break up any flocs which tend to contaminate the underflows of most conventional classifiers. Owing to this ability to distinguish between granular particles and those which settle by means of flocculation or other form of aggregation, the hydrocyclone is really a new tool which has already shown itself effective in the cleaning of fibrous pulps, such as paper and asbestos, and also offers some promise of separations according to particle shape.

A test set is available consisting of 15- and 30-mm.-diam. hydrocyclones in *Pyrex*, each with three interchangeable vortex finders and five interchangeable apex nozzles of different diameters, fitting by means of precision-ground glass joints, and the whole is complete in a polished wooden case. Liquid-Solid Separations Ltd. are the suppliers. **CPE 858**

Tanks made to measure

Premier Colloid Mills Ltd., of Walton-on-Thames, offer to design and produce tanks to suit any process, including tanks up to a capacity of 100,000 gal., which can be stainless steel, jacketed, or with dished bases, as required. The company state that delivery can be within as little as 10 days, although the larger and more complicated types may take a little longer than the straightforward storage and mixing tanks of 200 to 300 gal. **CPE 859**

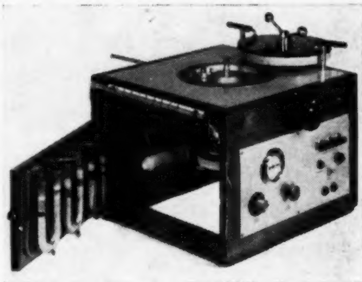
Leak detector

An instrument now being marketed by Winston is a radio-frequency mass spectrometer which, it is claimed, will detect and measure leaks of almost any size at any pressure range in vacuum and pressure systems and hermetically sealed units. **CPE 865**

'Tailor-made' tank with mixer.

Moisture determination

A new order of precision in moisture determination is claimed for the *Gardiner* vacuum oven in which the sample is taken into solution and distributed over an aluminium powder extender contained in a sample dish, and is then heated under vacuum,



Vacuum oven, soon to be available in Britain.

while a current of air or inert gas, dried to a water content not exceeding 0.0007 mg./l., is bled over its surface.

This oven was developed in the research laboratories of Tate & Lyle during an investigation of the difficulties of drying such labile products as sugar syrups and molasses containing fructose. The makers, Griffin & George Ltd., now envisage its wider use wherever reproducible results are required in determinations of loss of weight on heating. **CPE 860**

Only two moving parts in versatile new pump

A combination of light weight with tremendous suction power is achieved in a new pump which can tackle air and liquid in any proportion and run continuously 'on snore,' while its simple positive action and low fluid velocity enable it to deal with thick and viscous fluids with ease.

This self-priming, self-lubricating pump is a positive axial-flow unit employing an Archimedean-type screw which engages with a rotating plate to produce a pulseless action that is virtually positive. Three sizes of the pump requiring prime movers of from $\frac{1}{3}$ to 16 b.h.p. cover a range of outputs from $4\frac{1}{2}$ to 167 gal./min. against heads of from 50 to 200 ft. The $1\frac{1}{2}$-in. model, for instance, weighing only 11 lb. and measuring 8 in. × 4 in. × 9 in. can deliver (at 3,000 r.p.m.) 31 gal./min. against a 200-ft. head and requires a prime mover of 3.1 b.h.p. only.

Pumps that are considerably bigger than this will be available and among

those produced so far is a vertical, marine pump whose characteristics make it useful for factory and process duties.

The symmetrical design of the pump means that the rotor can turn in a clockwise or anti-clockwise direction, which means that the direction of flow can be chosen at will. Mechanical face seals, running on ground and lapped faces, completely seal the shaft. A chamber between the seals and the bearings is fully vented to atmosphere, thus ensuring that no fluid pressure can possibly build up against the bearing assembly.

A special relief valve is supplied where shut-down valves are incorporated on the delivery side.

Various materials of construction are employed, according to the application envisaged. Very promising experiments with one of the newest chemical plating processes indicate that shortly the pumps will be available with a nickel finish inside and outside.

Makers of these pumps are Goodyear Pumps Ltd., a subsidiary of Holman Bros. Ltd. **CPE 861**

Plastic pipes for special applications

A range of thermoplastic pipes offers resistance to solvents, strong acids, alkali solutions and aromatic hydrocarbons, as well as to pressure and temperature.

Type Z semi-rigid fittings are designed for lower temperatures and pressures. Pipes are excellent for cold water, resistant to acids and alkalis and unaffected by corrosive waters or soils. They are not recommended for hydrocarbons. They may be used continuously at temperatures up to 158°F., and for short periods at very low pressures up to 212°F.

Type K rigid fittings are for lower temperatures and moderate pressures. This is said to be an excellent cold water and sewer pipe, with very good resistance to most chemicals, but it is not recommended for aromatic hydrocarbons, chlorinated solvents, and others. It will handle natural gas and many sour crude oils. It may be used for temperatures up to 170°F., and for short periods at very low pressures up to 212°F.

Type N are high-temperature and -pressure pipes for the process and crude oil industries and for marine work. They are not recommended for carrying acetic, nitric, sulphuric, and hydrochloric acids and a number of other chemicals, but may be used in process and effluent lines up to 212°F. under pressure. A special grade is available for temperatures up to 300°F. at no extra cost.

A range of standard fittings is available from the makers, H. Incledon & Co. Ltd. **CPE 862**

Remote control of storage tank levels

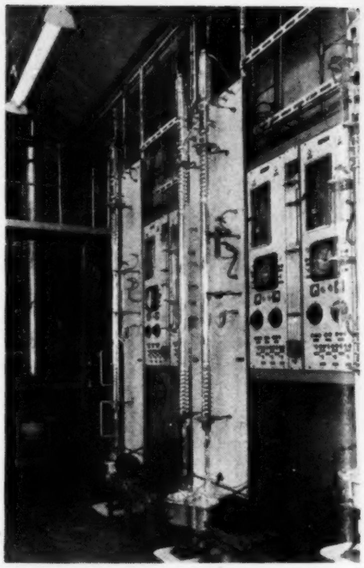
The central control of widely dispersed tank farms through remote level indication can greatly speed pumping and transfer operations, and two systems have been designed by Whessoe Ltd. which can be used within a range of a few miles.

In the *Desynn* system the standard control equipment, consisting of a level gauge, transmitter, flameproof relay box (one for each pair of tanks) and control panel, allows 18 tanks to be individually gauged from one central station.

The *Selsyn* system is similar, except that all the equipment has been designed for multi-core armoured cables and employs separate junction and relay boxes, which in the case of the *Desynn* system were housed in the two tank relay boxes. Both employ two transmitters and two receivers, one for inches, the other for feet, and all equipment is flameproof to B.S.S. 229 : 1946 for groups 2 and 3 gases. **CPE 863**

Versatile fractionators

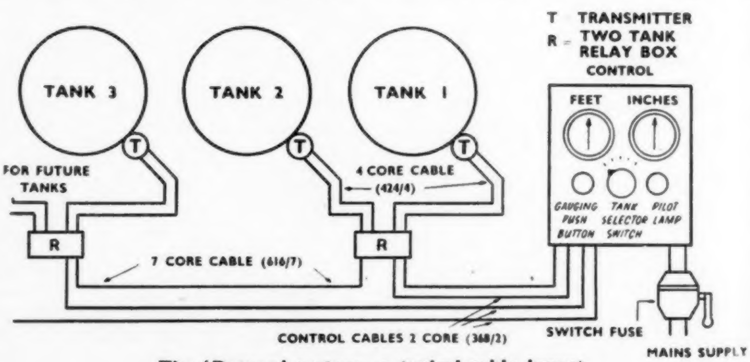
Fractionating columns used at the research station of the British Petroleum Co. Ltd. for the purification of hydrocarbons and sulphur compounds are designed for use with a variety of ' random ' packings such as Dixon gauze rings and glass helices. When packed with the former the separating efficiency is over 100 T.P. For the fractionation of materials which may be adversely affected by contact with metal packings, glass helices may be employed which give an efficiency of about 50 T.P.



Fractionating colums at B.P.'s research laboratory are designed for use with a variety of ' random ' packings.

Operating the columns at reduced pressures enables the separation of compounds which have atmospheric boiling point up to and a little above 300°C., while the vapour-dividing head allows azeotropes to be handled and, by having the off-take arm heated, materials normally solid at room temperature may be separated and removed.

The columns, being vacuum-jacketed, do not need jacket heating and the controls necessary for this, while heat loss from the ground-glass joints is kept to a minimum and, by using PTFE sleeves, the problem of grease contamination does not arise. The columns may be easily dismantled and re-erected. **CPE 864**



The 'Desynn' system—a typical cable layout.

Personal Paragraphs

★ **Mr. B. W. Jesser** has been appointed manager of Kellogg International Corporation, London, a subsidiary of M. W. Kellogg, which is itself a subsidiary of Pullman Inc. He will relieve **Mr. F. E. Johnson, Jr.,** who has been manager of Kellogg International for four years and who has just been named an assistant engineering vice-president of M. W. Kellogg. Mr. Jesser was a contract operations staff engineer and was formerly manager of Kellogg's design engineering department. He has been with the company since 1942. Prior to this he was an instructor in chemical engineering at Princeton University and was with Du Pont.

★ **Mr. D. C. F. Devos,** managing director of Courtauld's chemicals division, has retired after 38 years' service with the company, most of it being devoted to chemical and viscose rayon manufacturing activities. He started at their Trafford Park sulphuric acid and carbon disulphide works in 1920 shortly after it was first opened. In the 1930s, after six years as general manager of Courtauld's French company, Les Files de Calais, Mr. Devos was responsible for the design of new viscose rayon processing equipment. Since the war he played a leading part in the further development of Courtaulds' sulphuric acid and carbon disulphide manufacturing activities. He was also a director of the United Sulphuric Acid Corporation, the British Sulphur Corporation and the Sulphur Exploration Syndicate. He served, too, for many years on the Council and various committees of the National Sulphuric Acid Association.

★ **Mr. W. Carter** has been appointed a director of Albright & Wilson Ltd. He joined the company in 1940 and, after filling a succession of positions on the management side, was appointed the first managing director of the operating company, Albright & Wilson (Mfg.) Ltd., on its formation in 1957.

★ **Mr. L. H. Cooper,** chairman of the Mond Nickel Co. Ltd., and vice-chairman of the International Nickel Co. of Canada Ltd., has been elected a director of that company.

★ A number of new appointments made by the United Kingdom Atomic Energy Authority includes that of **Mr. J. C. C. Stewart,** formerly Director of Technical Policy in the Industrial Group at Risley, to Deputy Managing Director of the Industrial Group. **Mr. J. B. W. Cunningham,** formerly Deputy Director (Civil Reactors), becomes Director of Industrial Power in the Industrial Group. **Dr. R. Hurst,** formerly Chief Chemist in the Research and Development Branch of the Industrial Group at Risley, becomes Director of the Dounreay Experimental Reactor Establishment. **Mr. D. S. Mitchell,** formerly Director of Administration, becomes Director of Personnel and Administration in the Industrial Group. All these appointments, which took effect on February 1, 1958, mark a first stage towards implementing recommendations made by the Committee appointed by the Prime Minister under the chairmanship of Sir Alexander Fleck to examine the organisation of certain parts of the Authority. Further appointments will be announced in due course.

★ **Mr. D. W. Fry,** Chief Physicist at Harwell, has been appointed a Deputy Director of the Atomic Energy Research Establishment.

★ **Mr. R. J. Kingsnorth** has been appointed manager of the process control division of Elliott Bros. (London) Ltd., a member of the Elliott-Automation Group. For the past 17 years Mr. Kingsnorth has been manager of the Erith instrument factory of Salford Electrical Instruments Ltd.

★ **Mr. C. N. Ford,** works manager, and **Mr. S. H. A. Hirsch,** B.SC., F.R.I.C., technical sales manager, have been appointed to the board of Vinyl Products Ltd.

Mr. B. W. Jesser.

★ **Mr. M. J. Howard,** who had been chief account to Price's (Bromborough) Ltd. since May last year, has been appointed to the board of the company.

★ **Mr. T. E. Potts** has been appointed a managing director of the British Oxygen Co. Ltd.

★ **Mr. M. Turner Clark** has been appointed chief chemist at the Cricklewood laboratory of British Oxygen Gases Ltd. He succeeds **Mr. C. Coulson-Smith,** who has retired. Mr. Clark has worked at the Cricklewood laboratory for the past 27 years. His activities recently have been concerned with the production control of acetylene.

★ **Mr. W. J. Proctor,** sales director of Follsain-Wycliffe Foundries Ltd., is at present in southern Africa and will be making a comprehensive tour of Northern and Southern Rhodesia with the object of carrying out a sales survey and in order to appoint agents to handle the company's heat- and abrasion-resisting castings, *Pulmac* pulverising mills and also variable speed gear boxes and speed reducers manufactured by their subsidiary company, Varatio-Strateline Gears Ltd.

★ **Mr. K. A. M. Barton** (sales director) and **Dr. R. A. Gregory** (production director) have been appointed joint managing directors of Midland Silicones Ltd. **Mr. S. Barratt,** the former managing director, continues to serve on the board as a non-executive director. He was recently appointed chairman of Albright & Wilson Ltd., the parent company.

★ More than 250 people gathered together at a presentation luncheon at the Whitehaven (Cumberland) plant of Marchon Products Ltd. recently to bid farewell to **Mr. F. Marzillier,** until recently vice-chairman of the company and its subsidiary, Solway Chemicals Ltd. Mr. Marzillier recently left Cumberland to live in semi-retirement in the south of England.

★ **Mr. N. J. Travis,** managing director of British Visqueen Ltd., a subsidiary of Imperial Chemical Industries Ltd., has resigned from the company after 20 years' service with I.C.I. and its associated companies. He has joined the board of Borax Consolidated Ltd. He is succeeded in British Visqueen Ltd. by **Mr. A. R. Thom,** who joined I.C.I. in 1946, and was associated with the development of polythene film in its early days.

Technology Notebook

Science and technology grants

The Department of Scientific and Industrial Research will again offer awards this year for post-graduate training in science and technology—and a new edition of 'Notes on D.S.I.R. Grants for Graduate Students and Research Workers,' just published (H.M.S.O., 1s. 6d.), provides full details of the scheme.

Last year, 649 new research studentships were awarded by D.S.I.R., in addition to those which were renewed for second and third years.

Freezing and drying

The Institute of Biology is arranging a symposium on freezing and drying to discuss progress in this field since the first international symposium held in 1951. The meeting is to be held at Senate House, London, W.C.1, on April 1 and 2. Some 20 speakers, including workers from France, Japan, Kenya, the U.S.A. and the U.S.S.R., have accepted invitations. A programme can be obtained from the Institute of Biology, 41 Queen's Gate, London, S.W.7.

Britain and world power supplies

The theme of the tenth British Electrical Power Convention, to be held at Brighton from June 16 to 20 under the presidency of Sir George Nelson, will be 'Electricity and World Progress: Britain's Contribution.' Papers to be presented include: 'The Development of Nuclear Energy for Electricity Supply in Great Britain,' by Sir Christopher Hinton, K.B.E., chairman of the Central Electricity Generating Board; 'The Development of Nuclear Energy for Electricity Supply Overseas,' by Sir Claude Gibb, K.B.E., chairman and managing director of C. A. Parsons & Co. Ltd; 'Britain's Part in Electrical Development Overseas,' by Mr. H. J. Beard, a partner in the firm of Merz & McLellan, consulting engineers; and 'British Hydro-electric Plant and World Power Requirements,' by three members of the staff of the English Electric Co. Ltd.

I.C.I. Fellowships

Imperial Chemical Industries Ltd. are making important changes in their scheme of post-doctorate Fellowships for research in chemistry, physics, engineering and related sciences. In future, the Fellowship Scheme will apply to all Universities in the U.K. The number of Fellowships will be increased from 92 to 103. Individual Fellowships will range in value between £700 and £1,000 p.a. and average £900—an increase of £100 p.a. over the old figure.

New chemical engineering research and development station

Constructors John Brown Ltd. have recently established a research and development station at Leatherhead, Surrey, the primary object of which will be to undertake sponsored development work on behalf of Government departments and industrial organisations, and also for the engineering and construction divisions of C.J.B. It will cover process development and investigation of chemical engineering problems; development of automatic control systems and their application; and special problems of nuclear engineering.

The new station has a site of four acres and is equipped with laboratories and pilot-plant buildings. Special attention has been given to facilities for development work requiring large-scale pilot plants. The station has started with a staff of 30, consisting of chemical engineers with experience in process development work, of automatic control engineers, and of supporting staff for chemical, physical, mathematical and design work.

Fellowship awards

The Mond Nickel Fellowships Committee announced recently the award of a Fellowship for 1957 to Mr. E. J. Williams (John Summers & Sons Ltd.) to study the research and production techniques, quality control and metallurgy of high-quality low-carbon strip steel in the United Kingdom, the Continent, and the United States; and to Mr. R. J. D. Acheson (Mufulira Copper Mines Ltd.) to study the extraction and refining processes for copper and allied metals, with particular reference to economic aspects.

The Committee is now inviting applications for Fellowships of an approximate value of £900 to £1,200 for 1958. Fellowships will be awarded to selected candidates of British nationality with degree or equivalent qualifications to enable them to obtain wider experience and additional training in industrial establishments, at home or abroad, to make them more suitable for future employment in senior technical and administrative positions in British metallurgical industries. Particulars are available from the Committee at 4 Grosvenor Gardens, London, S.W.1.

MEETINGS

Institution of Chemical Engineers

March 12. 'Sulphuric Acid from Anhydrite at Whitehaven,' by A. C. Halfpenny, 7 p.m., University of Leeds.

March 18. 'Heat Transfer in Relation to Nuclear Engineering,' by W. B. Hall, 7 p.m., College of Science and Technology, Manchester.

Graduates' and Students' Section

March 19. 'Gas/Solid Reactions in Fluidised Beds,' by Prof. E. S. Sellers, 7 p.m., University College, Cardiff.

Incorporated Plant Engineers

March 19. 'High-pressure Steam Generation,' by O. S. Denham, 7 p.m., King's Head Hotel, High Street, Rochester.

March 20. 'The Construction of a Nuclear Power Station,' 7 p.m., College of Preceptors, Bloomsbury Square, London, W.C.1.

Institute of Petroleum

April 2. 'Electrostatics and Explosion Hazards in the Petroleum Industry,' by Dr. A. Klinkenberg, 5.30 p.m., 26 Portland Place, London, W.1.

Institute of Metals

March 10. 'A Metallurgist in the Chemical Industry,' by L. Powell, 6.30 p.m., 39 Elmbank Crescent, Glasgow, C.2.

April 3. 'New Protective Coatings for Metals,' by W. E. Ballard, 6.30 p.m., 17 Belgrave Square, London, S.W.1.

INTERNATIONAL CONFERENCE

March 17-21. National Association of Corrosion Engineers, San Francisco, California, U.S.A.